JAN 15 1925

ENGINEERING:

An Illustrated Weekly Journal.

OFFICES FOR ADVERTISEMENTS AND PUBLICATION, 35 & 36, BEDFORD STREET, STRAND, LONDON, W.C.2.

VOL. CXIX.—No. 3079.] *LONDON: FRIDAY, JANUARY 2, 1925.* [*Registered at the General Post Office as a Newspaper.*] [PRICE ... 1s. BY INLAND POST 1s. 2½d.

Aveling & Porter, Ltd.,
ROCHESTER.
Steam & Crude Oil Road Rollers, &c.
1869

A. G. Mumford, Ltd.,
CULVER STREET WORKS, COLCHESTER.
ON ADMIRALTY AND WAR OFFICE LISTS.
ENGINES for Torpedo Boats, Yachts, Launches. BOILER FEED PUMPS.
See Advertisement page 34.
PATENT WATER-TUBE BOILERS. AUTOMATIC FEED. RS.
And Auxiliary Machinery as supplied to the Admiralty. 2179

E. J. Davis, M.I.Mech.E.,
Gas Engines Inspected. Tested and Reported upon. Over 25 years' experience. Tel.: Maryland 1736 & 1737. Wire: "Rapidising London." —Great Eastern Road, Stratford, E. 15. 1794

Spencer-Hopwood & Kirke
PATENT BOILERS. *See page 49, Dec. 26.* 1994
Sole Makers: SPENCER BONECOURT, LTD., Parliament Mansions, Victoria St., London, S.W.

The Glasgow Railway Engineering Company,
GOVAN, GLASGOW. LTD.,
London Office—12, Victoria Street, S.W.
MANUFACTURERS OF RAILWAY CARRIAGE, WAGON & TRAMWAY WHEELS & AXLES.
CARRIAGE & WAGON IRONWORK, also CAST-STEEL AXLE BOXES. 1948

Patent
See's Hydro-Pneumatic Ash Ejector
Great saving of labour. No noise. No dust. No dirt. Ashes discharged 20 ft. clear of vessel.—Apply, F. J. TREWENT & PROCTOR, LTD., Naval Architects and Surveyors, 43, Billiter Bldgs., Billiter St., London, E.C. Od 4835

ON ADMIRALTY LIST.

John Kirkaldy, Ltd.,
London Office: 101, LEADENHALL ST., E.C.3.
Works: BURNT MILL, near HARLOW, ESSEX.
Makers of
Evaporating and Distilling Plants.
Refrigerating and Ice-making Machinery.
Feed Water Heaters.
Evaporators.
Fresh Water Distillers.
Main Feed Pumps.
Combined Circulating and Air Pumps.
Auxiliary Surface Condensers, &c., &c. 2327

Forgings & Stampings.
FELLOWS BROS., LTD., CRADLEY HEATH, STAFFS. 9155

Tank Locomotives.
Specification and Workmanship equal to Main Line Locomotives.
R. & W. HAWTHORN, LESLIE & CO. LTD., ENGINEERS, NEWCASTLE-ON-TYNE. 1864

Steam Hammers (with or without guides). Hand-worked or self-acting TOOLS for SHIPBUILDERS & BOILERMAKERS. 1914
DAVIS & PRIMROSE, LIMITED, LEITH, EDINBURGH.

Bever, Dorling & Co., Ltd.,
BRADFORD.
HIGH-CLASS ENGINES FOR ALL PURPOSES, also WINDING, HAULING, AIR COMPRESSING and PUMPING ENGINES. 1896

GOLD MEDAL-INVENTIONS EXHIBITION-AWARDED
Duckham's Patent Suspended
WEIGHING MACHINES—EAST FERRY ROAD ENGINEERING WORKS COMPANY, LTD. LONDON, E.—Hydraulic Cranes, Grain Elevators, &c.
See illus. Advt. last week, page 17. 2420

CRANES. All Types.
GEORGE RUSSELL & CO., LTD., Motherwell. 1867
Telegrams:—"Cylinders," Birmingham.

Weldless-Steel Tubes
for Water-tube Boilers, Superheaters, Shafting, Hydraulic Work, Boring Rods, &c.
TUBES LIMITED, BIRMINGHAM. 06179

YARROW & CO. (1922), LTD., GLASGOW.
PASSENGER AND CARGO STEAMERS.
SHALLOW DRAFT VESSELS. 2276

Campbells & Hunter, Ltd.
SPECIALISTS IN
Drillers & Boring Machinery
for Engine Works and Boiler Shops.
DOLPHIN FOUNDRY, LEEDS. 4547

VOSPER & Co., LTD.,
PORTSMOUTH.
SHIP & LAUNCH BUILDERS, Od 3551
ENGINEERS & BOILER MAKERS.

For Your Repairs or any
SPECIAL MACHINERY, try
THOMAS HUNT & SONS,
Albion Ironworks,
Bridge Road West, Battersea, S.W.11.
Est. 1854. 2487

The Mitchell Conveyor and
TRANSPORTER CO., LTD.,
CONTRACTING ENGINEERS.
DESIGNERS and BUILDERS
of
all Classes of HANDLING MACHINERY.
Atlantic House,
45-50, Holborn Viaduct,
London, E.C. 1.
Telegrams: "Micontraco, Cent, London."
Telephone: Holborn 3822. 2418

Dredging Plant—
For ALLUVIAL GOLD, PLATINUM & TIN, HARBOUR, RIVER & CANAL.—Gravel Dredgers, SCREENS.—DREDGE BUCKETS & Parts, all sizes.
ARTHUR R. BROWN,
54, New Broad Street, London, E.C.2.
Telephone: London Wall 3418. 2509

RAILWAY AND TRAMWAY ROLLING STOCK.
Hurst, Nelson & Co., Ltd.,
THE GLASGOW ROLLING STOCK AND PLANT WORKS, MOTHERWELL. Od 3383

For Sale or to Feu in Whole
OR PLOTS.
68 ACRES OF GROUND AND BUILDINGS, suitable for works, at Inchinnan, on the main road between Glasgow and Greenock.
One building, length 250 ft. by 150 ft., height 48 ft. to eaves, structure of brick and steel, lit from roof, contains approximately 37,500 sq. ft. floor space.
One building, in several bays, 330 ft. long at the longest part 258 ft. broad, height one part 24 ft. 6 in. to eaves, other part 16 ft. to eaves, structure of brick and steel, lit from sides and roofs, granolithic floors, mechanically heated, contains approximately 83,000 sq. ft. floor space.
One building 320 ft. long by 160 ft. broad, height, 16 ft. 9 in. to eaves, with small annex 50 ft. by 30 ft. structure of brick and steel, granolithic floors, lit from sides and roof, mechanically heated, approximately 53,000 sq. ft. floor space.
Electric power is laid into each of these buildings from the Clyde Valley Power Station, also water supply.
For further particulars apply to:—
WEARING & MARTIN, Writers, 180, Hope Street, Glasgow. 2346

Iron and Steel
Tubes and Fittings.
Sole Licensees in Great Britain for the manufacture of "Armco" Rust and Corrosion Resisting Iron Tubes. 2257
The Scottish Tube Co., Ltd.,
HEAD OFFICE: 34, Robertson Street, Glasgow.
See Advertisement page 33 and 44.

Royles Limited,
ENGINEERS, IRLAM, MANCHESTER.
FEED WATER HEATERS, CALORIFIERS, EVAPORATORS, CONDENSERS, AIR HEATERS, STEAM and GAS KETTLES } Row's Patents.
Merrill's Patent TWIN STRAINERS for Pump Suctions.
SYPHONIA STEAM TRAPS. REDUCING VALVES
High-class GUNMETAL STEAM FITTINGS.
WATER SOFTENING and FILTERING. 5723

IRON & STEEL
Tubes and Fittings
AND
Steel Plates.
STEWARTS AND LLOYDS, Ltd.
GLASGOW BIRMINGHAM LONDON.
See Advertisement, page 27. 1872

Cement—Maxted & Knott,
Ltd., Consulting Cement Engineers, ADVISE GENERALLY on proposed Cement Schemes FOR ENGLAND AND ABROAD. ADVICE ONLY. Highest references. Established 1890.
Address, BURNETT AVENUE, HULL.
Cablegrams: "Energy, Hull." 1828

James D. Roots.—Patents,
BRITISH and FOREIGN. Moderate charges. Long and varied practical Engineering experience valuable to inventors. Formerly many years contributor of Patents Abstracts for "The Engineer" & "The Times."—Thanet House, Temple Bar, London, W.C.2

THE GLASGOW ROLLING STOCK AND PLANT WORKS.
Hurst, Nelson & Co., Ltd.,
Builders of RAILWAY CARRIAGES, WAGONS ELECTRIC CARS, and EVERY OTHER DESCRIPTION OF RAILWAY and TRAMWAY ROLLING STOCK.
Makers of WHEELS and AXLES, RAILWAY PLANT, FORGINGS, SMITH WORK, IRON & BRASS CASTINGS, PRESSED STEEL WORK OF ALL KINDS. Od3382
Reg. Office and Chief Works: Motherwell. London Office: 32, Great St. Helen's, Bishopgate, E.C. 3.

Regent Guillotine Shears and Power Presses
FOR SHEET AND PLATE WORKING.
THE REGENT SHEET METAL MACHINE TOOL CO., LTD., REGENT WORKS, WAKEFIELD. 2015

P. & W. MacLellan, Ltd.,
CLUTHA WORKS, GLASGOW.
MANUFACTURERS OF RAILWAY CARRIAGES AND WAGONS OF EVERY DESCRIPTION.
RAILWAY IRONWORK, BRIDGES, ROOFING, &c.
Chief Offices: 129, Trongate, Glasgow. Od 8547
Registered Offices: Clutha House, 10, Princes St., Westminster, S.W.1.

Govan Engine Works,
GLASGOW.
FOR SALE
IN WHOLE OR PLOTS.
GROUND extending to 42,672 square yards, and BUILDINGS thereon of Engine and Boiler Shops (lately belonging to Messrs. DUNSMUIR & JACKSON, Ltd.), equipped with Overhead Travelling Cranes up to 60 tons.
For particulars apply—
WEARING & MARTIN,
Writers,
180, Hope Street, Glasgow.
2347

YARROW & CO. (1922), LTD., GLASGOW.
LAND AND MARINE
YARROW BOILERS. 2277

John Bellamy Limited
MILLWALL, LONDON, E.
GENERAL CONSTRUCTIONAL ENGINEERS. 1216
Boilers, Tanks & Mooring Buoys
STILLS, PETROL TANKS, AIR RECEIVERS, STEEL CHIMNEYS, RIVETTED STEAM and VENTILATING PIPES, HOPPERS, SPECIAL WORK, REPAIRS OF ALL KINDS.

Head, Wrightson & Co.,
LIMITED.
See Advertisement page 23. 3402

TO CLOSE A TRUST.
For Sale, as a Going Concern,
BOILER and ENGINEERING WORKS, situate in Yorkshire, adapted for the Manufacture of all classes of Boiler, Tanks, Air Receivers, Steel Pipes, Pans, etc.
The Works comprise, Boiler-making, Flue and Fitting Shops, Boiler Shed and Sheds, and Offices.
The Site contains an area of 7320 square yards, or thereabouts, and is freehold.
For further particulars apply to Messrs. J. C. KIRK & SON, Chartered Accountants, Leeds. G 749

Railway Switches and Crossings.
T. SUMMERSON & SONS, LIMITED, DARLINGTON. 2006

WAYGOOD-OTIS LIFTS 2130
54 & 55, FETTER LANE, LONDON, E.C.4.
62 & 63, LIONEL STREET, BIRMINGHAM, and Principal Provincial Cities and Abroad.

Patents and Trademarks.—
Patent your Inventions, Trademark your goods. Advice, handbook and cons. free.—B. T. KING, C.I.M.E. (Regd. Pat. Agent, G.B., U.S.A. and Can.), 146a, Queen Victoria Street, E.C.4. 38 yrs. refs. 'Phone: 682 Central for full information. 1209

PROPELLERS
AND PROPULSION PROBLEMS.
Special designs only.
"Circulation Theory."
Akimoff Propeller Company,
PHILADELPHIA, U.S.A. 2349

BARGAINS FROM BOLTON.
High Speed Self-acting
RACK-DRIVEN
PLANING MACHINE,
by Beyer, Peacock.
To plane 16 ft. by 5 ft. by 5 ft.
Very heavy bed, about 24 ft. long, with planed Vee slides.
T-slotted table.
Massive cheeks to floor.
Four graduated tool boxes.
Weight of machine over 16 tons.
IN STOCK.
THOMAS MITCHELL & SONS, LTD., BOLTON. 2405

The Manchester Steam Users ASSOCIATION.

For the prevention of Steam Boiler Explosions and for the attainment of Economy in the Application of Steam. 9, MOUNT STREET, MANCHESTER.
Chief Engineer: C. E. STROMEYER, M.I.C.E
Founded 1854 by SIR WILLIAM FAIRBAIRN.
Certificates of Safety issued under the Factory and Worshops Act, 1901. Compensation for Damages and Liabilities paid in case of Explosions. Engines and Boilers inspected during construction. 2005

Correspondence Courses for

Inst. Civil Engrs., Inst.Mech.E., London Univ (Matric., Inter., B.Sc.), Inst.M. & Cy.E., and ALL ENGINEERING EXAMINATIONS personally conducted by Mr TREVOR W. PHILLIPS, B.Sc. (Honours) Eng. London, Assoc.M.Inst.C.E., Chartered Civil Engineer. M.R.S.I., F.R.S.A., etc. Also Day Tuition in Office. Excellent results at all Exams., comprising hundreds of successful Students. Courses may commence at any time, and all Students receive individual tuition.—For full particulars apply to 8/11, TRAFFORD CHAMBERS, 58 SOUTH JOHN STREET, LIVERPOOL. 1993

Draughtsmen, before

Negotiating with Government Departments in connection with any post, please communicate with the GENERAL SECRETARY, Association of Engineering and Shipbuilding Draughtsmen, 96, St. George's Square, London, S.W.1. G 758

TENDERS.

The Director-General,

INDIA STORE DEPARTMENT, Branch No. 16, Belvedere Road, Lambeth, S.E.1, REQUIRES
BODY IRONWORK AND FITTINGS for Railway Carriages.
Tenders due on the 23rd January, 1925.
Tender Forms obtainable from above. G 791

HIGH CARLEY SANATORIUM, near ULVERSTON.

For Sale, Hydro-Extractor,

36in. diameter. Can be seen on application to the Medical Superintendent. Offers should be sent to Dr. G. LISSANT COX, Central Tuberculosis Officer, County Offices, Preston. G 745

METROPOLITAN BOROUGH OF HAMMERSMITH.

ELECTRICITY DEPARTMENT.

The Undermentioned Super-

SEDED PLANT installed at Hammersmith Electricity Works, is OFFERED FOR SALE:—
Three Davey Paxman "Economic" type Boilers, with superheaters, including four steel storage vessels, economisers, pumps, piping, etc.
Specification and full particulars from the Deputy Engineer and Manager, Electricity Department, 85, Fulham Palace Road, London, W.6.
The dismantling and removal of the plant to be carried out by the purchaser at his own expense and risk.
Offers must be submitted to the Town Clerk, Town Hall, Hammersmith, W.6, properly endorsed, not later than Four p.m. on Friday, 16th January, 1925.

HUGH ROYLE,
Town Clerk.
Town Hall, Hammersmith, W.6.
22nd December, 1924. G 761

URBAN DISTRICT COUNCIL OF FLEET (HANTS).

EXTENSION OF EXISTING SEWERAGE AND SEWAGE DISPOSAL WORKS FOR FLEET.

UNEMPLOYMENT RELIEF WORKS. GENERAL CONTRACT.

DATE FOR RECEIPT OF TENDERS EXTENDED TO 21st JANUARY, 1925.

The Urban District Council of Fleet invite

Tenders from Responsible and

Experienced Contractors for the CONSTRUCTION of these WORKS, which comprise several miles of Cast Iron and Stoneware Sewers, Brick, Concrete and Cast Iron Manholes, Flushing Tanks, Ventilating Shafts and Columns, Cast Iron Rising Main, Air Main, and additions to the Sewage Disposal Works, and other incidental work.
A copy of the Specification and Form of Tender, and Bills of Quantities may be obtained and the drawings inspected, on and after the 3rd January, 1925 on application in writing, to MAJOR T. J. MOSS-FLOWER Chartered Civil Engineer, 28, Victoria Street, Westminster, S.W., and Carlton Chambers, Bristol, at his Bristol Office, on deposit of a £10 Bank of England Note which will be refunded provided a *bona fide* Tender be received, and is not withdrawn before the sealing by the Council of one of the Tenders, and provided also that all documents supplied be returned to the Engineer. On production of a receipt for the deposit, persons Tendering may inspect the plans at Fleet on a day and at a time and place which will be communicated to them.
The Contractor carrying out the work will be required to comply with the regulations of the Unemployment Grants Committee with regard to the employment of labour during the performance of the Contracts.
Sealed Tenders, endorsed "Tender for Fleet Sewerage and Sewage Disposal Works, General Contract," are to be delivered at the Council Offices, not later than Noon on the 21st January, 1925.
The lowest or any Tender will not necessarily be accepted.
Dated this 15th day of December, 1924.

ERNEST NASH,
Clerk to the Council.
Council Offices,
FLEET (Hants). G 777

Estimates are Required for

the supply and erection of COAL-HANDLING PLANT, by JOHN WATNEY & CO., LTD., The Distillery, York Road, Wandsworth, London, S.W.18. G 790

BOMBAY, BARODA & CENTRAL INDIA RAILWAY COMPANY.

The Directors are prepared to receive up to Noon on Wednesday, 14th January,

Tenders for Supply of :—

WHEEL CENTRES & AXLES FOR CARRIAGES & WAGONS.
Tenders must be made on forms, copies of which, with Specification, can be obtained at these Offices on payment of 10s. each (which will not be returned). The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG,
Secretary.
Offices: 91, Petty France, Westminster, S.W.1.
29th December, 1924. G 787

METROPOLITAN BOROUGH OF ISLINGTON.

Tenders are Invited for the

SUPPLY, DELIVERY and ERECTION at Caledonian Road Baths, N., of ONE GAS-FIRED BOILER and ONE STORAGE CALORIFIER.
Form of Contract, etc., may be seen on application to the General Superintendent and Engineer, Hornsey Road Baths, N.7, from whom Specification, Form of Tender, and further information may be obtained.
Tenders, endorsed "Tender for Boiler and Calorifier," must be delivered to the undersigned not later than Noon on Wednesday, 21st January, 1925.

By Order,
C. G. E. FLETCHER,
Town Clerk.
Municipal Offices, Tyndale Place, N.1.
29th December, 1924. G 779

LIVERPOOL CORPORATION ELECTRIC SUPPLY DEPARTMENT.

PLANT FOR SALE.

The CORPORATION OF LIVERPOOL invite

Offers for the Purchase and

REMOVAL of FIVE 200 K.W. MOTOR GENERATORS, now lying at the Pumpfields Station, Vauxhall Road, Liverpool.
Each Motor Generator consists of an A.C. 6000 volts, 3-phase 50 period Squirrel Cage Motor, and a D.C. 470/525 volt Generator.
The full load speed of the machines is 420 r.p.m. and output 400 amperes at 500 volts. The machines are in thorough working order, and have been removed to make room for larger plant.
The machines may be inspected by arrangement with the City Electrical Engineer, 24, Hatton Garden, Liverpool, from whom further particulars may be obtained.
Offers should be delivered to the City Electrical Engineer not later than 16th January, 1925, and endorsed "Offer for Electric Plant."
The Corporation do not bind themselves to accept the highest or any offer.

WALTER MOON,
Town Clerk. G 774

CITY OF BIRMINGHAM WATER DEPARTMENT.

BARTLEY RESERVOIR.

The WATER COMMITTEE invite

Tenders for the Construction

of the BARTLEY RESERVOIR, on a site adjoining their existing Reservoir at Frankley, near Birmingham.
The Reservoir will be a Storage Reservoir with a content of over 100 million gallons. The Works will comprise the following:—
An Earthen Embankment with shallow cut-off trench and reinforced concrete core wall, valve tower with reinforced concrete footbridge, outlet culvert and pressure tunnel, inlet culvert and channel, inlet gauge chamber and recorder house, reservoir lining consisting of pre-cast concrete slabs, reinforced concrete in situ, pitching and beaching, road diversions, and other subsidiary works.
Conditions of Contract (which include the Corporation's usual fair wages and conditions of labour clauses), Specifications and Forms of Tender may be obtained on and after December 30th, 1924, from the Secretary, Water Department, Council House, Birmingham.
All applications for Tender Forms must be accompanied by a deposit of £10, which will be returned to the applicant on receipt of a *bona fide* Tender.
The Drawings may be seen at the Water Department Offices (Secretary's Office entrance), Council House, between the hours of Ten a.m. and One p.m., on December 30th, 1924, January 2nd, 6th, 9th, 13th, 16th and 20th, 1925. An Assistant Engineer will be in attendance on these dates between Eleven a.m. and One p.m. After Two p.m. he will attend at the Reservoir site to afford any further information to Tenderers.
Tenderers desiring to have copies of any of the drawings, to assist them in preparing their Tenders, will be supplied with such copies on payment to the Secretary of 2s. 6d. per copy, which amount will not be returned. All Drawings so supplied must be returned to the Secretary under separate cover at the same time as the Tender is submitted.
Tenders must be delivered under seal, addressed to "The Secretary, Water Department, Council House, Birmingham," endorsed "TENDER FOR BARTLEY RESERVOIR, CONTRACT No. 12," not later than Noon, on 26th January, 1925.
The Committee do not bind themselves to accept the lowest or any Tender.

J. H. BROADLEY,
Secretary.
Water Department,
Council House,
Edmund Street,
Birmingham.
19th December, 1924. G 748

THE GREAT INDIAN PENINSULA RAILWAY COMPANY, 48, Copthall Avenue, London, E.C.2, invite

Tenders for :—

1. IRONWORK for Vestibules of Corridor Carriages. Fee 5/-.
Tenders are due by 11 a.m. on 13th January, 1925. Tender forms obtainable at above address. Fees not returnable. G 801

METROPOLITAN ASYLUMS BOARD.

TO ELECTRICAL ENGINEERS.

The Board invite

Tenders for Alterations and

EXTENSIONS to ELECTRIC LIGHTING in Wards at the Western Fever Hospital, Seagrave Road, Fulham, S.W.6., in accordance with Specification prepared by Mr. THOMAS COOPER, M.I.C.E., M.I.M.E., Engineer-in-Chief. Specification and Form of Tender may be inspected at the Office of the Board, Victoria Embankment, London, E.C.4, on and after Ten a.m. on Friday, 2nd January, 1925, and can then be obtained upon payment of a deposit of £1. The amount of the deposit will be returned only after the receipt of a *bona fide* Tender sent in accordance with the instructions on the Form of Tender and after the Specification has been returned.
Tenders, addressed as noted on the Form, must be delivered at the Office of the Board not later than 2.30 p.m. on Wednesday, January 28th, 1925.

G. A. POWELL,
Clerk to the Board. G 798

TENDERS FOR SUPPLY OF RAILWAY MATERIAL AND STORES.

Sealed Tenders with

necessary samples, will be received by the Stores Committee, Bikaner (India), up to Three p.m. on 15th March, 1925, for the SUPPLY of RAILWAY MATERIAL and STORES, ELECTRIC STORES, MEDICINES, and KHAKI and WHITE DRILLS for uniforms, for 12 months' requirements.
Tender Forms and lists of the above-mentioned articles, and with approximate quantity and description and conditions on which the Tenders will be considered, may be had on application to the undersigned on payment of 10s.
Samples and drawings, if required, will also be sent on nominal value per V.P.P. or telegraphic application.
When submitting Tenders, nominal "Earnest Money," as mentioned in the Tender Form, must be deposited with and sent direct to the Treasury Officer, Bikaner (India), without which no Tender will be considered. This "Earnest Money" will be forfeited if the tenderer fails to deposit the required security of 10% in the case of the Tender being accepted. This will also be forfeited to the State should the successful tenderer fail to carry out the contract in terms and conditions of the Tender without the State having to prove any loss by transaction.
Deliveries are to be made in one lot, or in equal instalments, by a notice in writing from the Manager, Bikaner State Railway.
Stores Committee do not bind themselves to accept the lowest or any other Tender, or assign any reason for non-acceptance of the whole or part of any Tender.
The Committee reserve themselves the right of increasing or decreasing the quantities quoted.
It should be noted that this invitation to Tender is being published simultaneously in India also.
Any further information required can be had from the undersigned, and all correspondence should be in English.

NIHAL CHAND SARWAL,
Secretary,
Stores Committee,
BIKANER. G 794

APPOINTMENTS OPEN.

THE QUEEN'S UNIVERSITY OF BELFAST.

JUNIOR ASSISTANT IN ENGINEERING.

Applications are Invited for

the POST of JUNIOR ASSISTANT in the Department of Civil Engineering. Salary £200 per annum, duties to commence early in January, 1925.
Further particulars may be obtained from the undersigned by whom applications with testimonials must be received on or before Saturday, January 10th, 1925.

F. H. HUMMEL,
Professor of Engineering. G 750

Wanted, Experienced

Estimator, must be thoroughly conversant with details of Gasworks Plant of every description, also Structural Work.—Address, stating age, experience and salary required, G 775, Offices of ENGINEERING.

Estimator Required, Capable

of making estimates from project drawings for mechanical handling plants for coal and other materials. Only men with good experience and proved abilities need apply. State age, experience and salary required.—Address, G 753, Offices of ENGINEERING.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH.

One or Two Junior

ASSISTANTS are REQUIRED at the NATIONAL PHYSICAL LABORATORY. Candidates must have a good Honours Degree or equivalent qualification in Physics, Engineering or Electrical Engineering, preferably with some experience in research.
Scale of salary £178-15-£235 per annum plus Civil Service Bonus; present initial pay £272 9s. Superannuation provision will be made under the Federated Superannuation System for Universities, by a contribution of approximately 10 per cent. of salary from the Department and 5 per cent. from the Officer.
Preference will be given, other things being equal, to ex-service men. Application must be made on a form to be obtained from the Laboratory, and must be received by the DIRECTOR, National Physical Laboratory, Teddington, not later than January 17th. G 792

SOUTH STAFFORDSHIRE WATERWORKS COMPANY.

CIVIL ENGINEERING DEPARTMENT.

Applications are Invited for

the APPOINTMENT of SECOND CIVIL ENGINEERING ASSISTANT. Age 26-35 years.
Candidates must have had considerable experience in the design and maintenance of important Waterworks, including impounding reservoirs, large pumping units, reinforced concrete service reservoirs, detection of waste and the distribution of water throughout large areas of supply.
Applicants must be corporate Members of the Institution of Civil Engineers, having had responsible experience with a Water Company or Water Department of a Public Authority.
Ex-service men will receive preferential consideration.
Commencing salary £450 per annum, which is subject to deductions under the Company's Superannuation Scheme.
Applications, stating age, details of education, training, qualifications and particulars of experience accompanied by copies (only) of three recent testimonials endorsed "Civil Engineering Assistant," must be addressed and delivered to the undersigned not later than the 19th January, 1925.

FRED. J. DIXON, M.Inst.C.E.,
Engineer-in-Chief.
Engineer's Office,
26a, Paradise Street,
Birmingham. G 770

Machine Tool Sales-Engineer

REQUIRED Immediately for Japan. Sound machine tool training and previous experience essential. Preference will be given to applicants with a knowledge of railway shop work. Send particulars of experience, age, salary expected.—Address, G 768, Offices of ENGINEERING.

Machine Tool Sales-Engineer

will shortly be REQUIRED for Spain. Sound machine tool training and good knowledge of Spanish are essential. Send particulars of experience, age and salary expected.—Address, G 769, Offices of ENGINEERING.

CITY OF SHEFFIELD—WATER DEPARTMENT.

APPOINTMENT OF ASSISTANT ENGINEER.

Applications are Invited for

the APPOINTMENT of THIRD ENGINEERING ASSISTANT.
Age about 25 years.
Candidates must be qualified Engineers, have held a similar position, and have had practical experience in connection with the distribution of water, the maintenance of reservoirs and works, distributary pipes, and the methods employed in the detection and prevention of waste.
Commencing Salary £250 per annum. (Grade III.)
Applications, stating age, qualifications and experience, accompanied by copies of three recent testimonials endorsed "Engineering Assistant," to be sent to me not later than Monday, 12th January, 1925.

WILLIAM TERREY,
General Manager.
Town Hall, Sheffield.
17th December, 1924. G 735

Section Engineers (Six),

REQUIRED for the CONSTRUCTION BRANCH of the FEDERATED MALAY STATES RAILWAYS for four years' service with possible extension. Salary $400 a month rising to $475 a month by annual increments of $25 a month plus a temporary non-pensionable allowance of 10% which is liable to cancellation or revision, plus a commuted Field Allowance of $50 a month. The exhange value of the dollar, in sterling, is at present fixed by the Government at 2s. 4d., but its purchasing power in Malaya is at present considerably less than that of 2s 4d. in the United Kingdom. Free passage provided. On expiration of agreement a bonus of six months' salary may be allowed, provided the work and conduct of the person engaged has been in every way satisfactory. Candidates, age 30 to 38 and unmarried, must be fully qualified Railway Engineers who have received good training and experience on recognised European, American or Colonial Railways. Members or Associate Members of the Institution of Civil Engineers preferred.—Apply at once, by letter, stating age, whether married or single, and particulars of qualifications and experience to THE CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W.1, quoting at top of application M/13264. G 764

THE HIGH COMMISSIONER FOR INDIA REQUIRES.

An Assistant Electrical

ENGINEER for service in England.
The post is on a non-pensionable basis, and will be held in the first instance on probation for one year, during which period the services of the incumbent may be dispensed with at one month's notice. Thereafter service will be terminable by six months' notice on either side. Salary £300 per annum rising to £450 by annual increments of £15 to which is added a variable cost-of-living bonus on the Civil Service scale.
Candidates must have had a good education, Technical College and Works Training and subsequent experience, and be Associate Members of the Institute of Electrical Engineers.
The duties are generally similar to those of an Assistant to a Consulting Engineer, and the successful candidate will be required to prepare specifications for electrical plant and apparatus, report on tenders, carry out inspection and deal with technical correspondence.
Candidates must have special knowledge of telegraph, telephone and wireless equipment, and be well acquainted with principal systems of automatic telephone exchanges.
Applications, stating age, training and experience, and enclosing copies of recent testimonials, are to be sent to the DIRECTOR-GENERAL, India Store Department, Belvedere Road, S.E.1, not later than the 15th January, 1925. G 772

[JANUARY 2, 1925, VOL. CXIX.]

ENGINEERING.

GAS ENGINE PISTON AND EXHAUST VALVE TEMPERATURES.

By F. R. B. Watson, B.Sc., A.M.I.Mech.E.

To the designer of any type of internal-combustion engine a knowledge of the maximum temperatures likely to be attained by the parts in the cylinder is essential, as this enables him to choose materials most suited to withstand these temperatures for a considerable length of time. To the user of the engine also a knowledge of these maximum temperatures is important, but, in addition to that, he may often want to know how the working temperatures of these parts change under different conditions of running, and consequently it is more to the latter than the former that this short paper is likely to be of interest.

In an internal-combustion engine the temperature of the exhaust valve is governed mainly by the temperature of the exhaust gases as they sweep past the valve during the exhaust strokes. In a gas engine the mean temperature of these gases (assuming constant speed and mixture strength) increases with the load, decreases with the compression ratio and increases slightly when the engine is run with a hot jacket. Early ignition also has a marked effect in raising the temperature of the valve. The temperature of the piston increases with the load, the jacket water temperature and the compression ratio, and goes up very rapidly if the ignition is made too early. In this paper are given some of the results obtained during a series of eleven tests, at constant engine speed and using normal charges throughout, on a 12-i.h.p. Crossley gas engine, and these results show the variation in piston and exhaust valve temperatures in this engine brought about by changes in conditions of running similar to those referred to above.

The main object of these experiments was to obtain for this engine, when the load was increased by about equal increments from no load to nearly full load, simultaneous readings of temperature at piston centre and of exhaust valve at two jacket water temperatures fairly far apart (113 deg. F. and 167 deg. F. were chosen), and also with two compression ratios, 5 : 1 and 6·5 : 1, so as to deduce :

(*a*) Range of temperature in piston and valve from no load to full load.

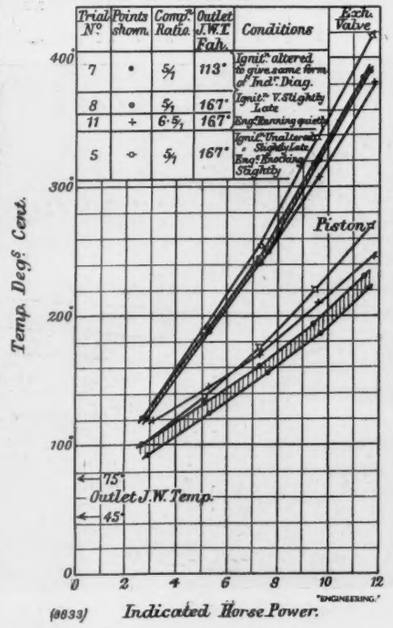
(*b*) Increase of temperature at piston centre and of valve for the 54 deg. F. (or 30 deg. C.) increase in jacket water temperature.

(*c*) Change of temperature in piston centre and valve due to the change of compression ratio given above.

A secondary object was to determine the heat flow to the jacket water at the same time as the temperatures were measured and this was done as accurately as possible, but this quantity does not enter much into this paper.

The engine used has a cylinder of 6·7 in. diameter and 15 in. stroke, and the governor was set for a speed of 230 r.p.m. The governing is by hit and miss, ignition by magneto and the engine used town gas. The ratio of compression is changed by changing the plates fitted behind the crank pin brasses, and the ignition can also be altered, while the engine is running, if need be.

In each trial observations of piston and valve temperatures were taken at five different loads starting at no load, and heat lost to jacket water, explosions, revolutions, brake load and gas consumption were determined and indicator diagrams taken at each of these loads. No alteration of any kind was made on the engine during these trials except the adjustment of the ignition where stated.



Iron-constantan thermo-couples were fitted in the piston and exhaust valve and they were connected to a millivoltmeter through a two-way plug key, the cold junctions being in ice. One scale division on the millivoltmeter, represented very nearly 5 deg. C., so that temperatures could be easily estimated to 1 deg. C.

The points of the couples were $\frac{1}{16}$ in. from the hot surface and the centre of the joint about $\frac{9}{32}$ in. from the hot surface in both couples, so, of course, the temperature readings were quite steady at that depth in the metal. The flat end of this piston is $\frac{3}{4}$ in. thick. No part of either of the couples broke and they were not interfered with in any way during the 11 tests.

Temperature observations taken in four trials are shown plotted in the figure, and the curves taken with the table below are self-explanatory. The actual figures for one pair of trials, Nos. 7 and 8, are given in the table.

Indicated Horse-power.		Piston Temperature, Deg. C.		Valve Temperature, Deg. C.	
J.W.T. = 113 Deg. F.	167 Deg. F.	113 Deg. F.	167 Deg. F.	113 Deg. F.	167 Deg. F.
2·90	2·60	92	100	120	120
5·33	5·00	124	132	189	185
7·60	7·24	154	160	250	245
9·72	9·40	185	193	320	317
11·65	11·32	221	230	389	384

The temperatures of piston are rather low, but these figures were obtained, like those in No. 11, by adjusting the ignition, so as to give the same form of indicator diagram throughout, a diagram having the explosion line inclined to the vertical and the ignition being very slightly late. This pair gave very uniform differences in piston and valve temperatures throughout. Trial No. 5 was one of a pair where the ignition was set slightly early (about 5 deg. difference between this and No. 8 at full load) the ignition the same at all loads, and the explosion line of diagram vertical. The two curves (valve and piston) for this trial when compared with those for No. 8 show the rapid rise of temperature in both valve and piston, but more especially in the latter, for this difference in timing. Early ignition also causes a marked increase in heat loss to the jacket—the measured loss at full load was about 10 per cent. greater in this trial than in No. 8. Trial No. 11 was one of a pair run at the higher compression, and it will be observed that the increase in piston temperature is not very great while the effect of the cooler exhaust gases is very noticeable on the valve temperature. By changing the jacket water temperature a succession of changes —more numerous than the experimenter generally cares to have at one time—is brought about, and the alteration in conditions in the cylinder produced by the change of this one temperature is remarkable. Volumetric efficiency, piston friction, temperature of gases in cylinder are three of the quantities affected by the hotter walls. Two of the effects produced are indicated in the figure in Nos. 7 and 8 by (*a*) the reduced i.h.p. and (*b*) the hotter valve. The measured heat loss to jacket is also much reduced chiefly by the increased radiation and to a lesser extent by the reduced piston friction.

For these trials, in which the aim was to keep quite near to ordinary working conditions of the engine and in which no attempt was made to get abnormally high temperatures either by means of rich mixtures or very early ignitions, the results may be briefly summarised thus :—

(*a*) Maximum temperature range (from no load to full load) in valve, 120 deg. to 416 deg. or nearly

300 deg. C., and in piston 100 deg. to 268 deg. or nearly 170 deg. C. (In an engine with piston of larger diameter the piston temperature would more nearly approach that of the valve. The late Professor Hopkinson quoted* for his 40 brake horse-power Crossley engine, temperatures of 400 deg. C., and 460 deg. C. for piston centre and exhaust valve, respectively, for normal setting of ignition.)

(*b*) The temperature of this piston does not increase much by changing the compression ratio from 5 : 1 to 6·5 : 1; about 12 deg. C. was measured, and there was practically no increase in measured total heat flow to jacket water. The valve is about 20 deg. C. cooler at full load, due to the cooler exhaust gases.

(*c* The increase of temperature at piston centre due to a 15 deg. C. rise in mean J.W. temperature seemed to come out less than this figure, in most of the trials. In Nos. 7 and 8 with 5 : 1 ratio the increase was 12 deg. C. and in Nos. 9 and 11 with 6·5 : 1 ratio it ranged from 14 deg. at half-load to 12 deg. at full load. But the differences generally were such that they could be accounted for by the reduced heat of friction with the hotter jacket. A slightly hotter valve (about 6 deg. to 10 deg. at full load) was obtained in all cases with the hotter jacket—presumably due more to the gases leaving the engine at a higher temperature than to the hotter seat.

The author desires to thank the Governors and the Principal of the Merchant Venturers' College, Bristol, for the facilities afforded for carrying out these experiments.

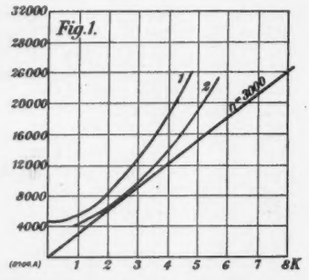
VIBRATION OF STEAM TURBINE DISCS.

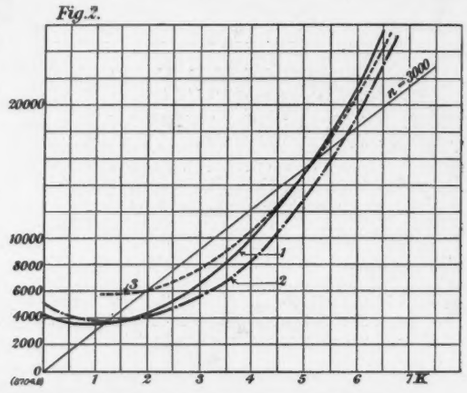
By Dr. J. von Freudenreich.

Introduction.

The idea is still prevalent† that it is very difficult to prevent the vibration of discs running at a high peripheral velocity. In this article it is shown that this is not the case, and that the whole problem of disc vibration can be solved with a high degree of accuracy, both experimentally as well as theoretically. There exists also the belief that high speeds are dangerous on account of disc vibrations. Actually, the reverse appears to be the case, *i.e.*, a disc has a higher factor of safety against vibration the higher the speed of rotation, provided, of course, that the centrifugal stresses do not exceed the safe limit of stress of the material of the disc.

With the exception of a few particular instances, the problem of disc vibration became one of importance only a few years ago, when the increase of the power demanded from a single turbine unit necessitated increasingly larger discs. This maximum permissible disc diameter is of particular importance in the case of the so-called "limit turbines," *i.e.*, turbines, which for a given speed, vacuum, and minimum leaving losses, develop the maximum output possible. This maximum output increases, of course, as improvements are made in the materials employed. For example, the alloy steels have increased considerably the maximum permissible stress in discs, not only because the strength and ductility of such steels are greater than those of ordinary steel, but because they also lend themselves more readily to heat treatment, with the result that a more homogeneous material is obtainable; thus, in spite of higher stresses, a greater degree of safety is ensured. One of the results of this endeavour to increase the output of the "limit turbine" and to keep the running speed below the critical speed of the shaft has been that comparatively thin discs were designed, which gave rise to a new danger, namely, that of disc vibration.* Vibrations may arise from various causes, as, for example, from partial admission, unequal types of nozzles, inaccuracies in the coupling, deflection of the shaft, &c. If the induced vibration is in resonance with the natural frequency of vibration of the disc, then the amplitude of the vibration will become so large that eventually the disc will fail through fatigue.





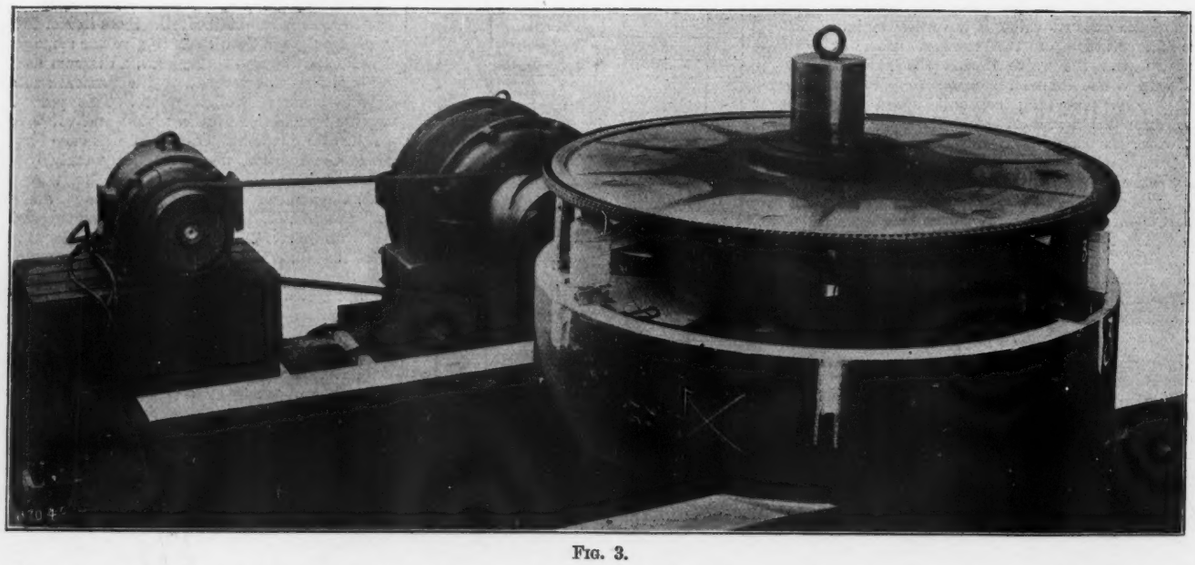


Fig. 3.

In order to determine with accuracy the laws governing the vibration of discs, Messrs. Brown, Boveri and Co., Limited, Baden, Switzerland, carried out a series of tests both on rotating as well as on stationary discs. These tests were undertaken with the co-operation of Professor Stodola, who, from a theoretical consideration of the problem, was able to suggest the best lines along which such tests should be planned, thus reducing the work to a minimum. The results of the tests provided an accurate check on the theoretical calculations, and it has therefore been possible to examine and explain very fully the problem of disc vibration. The results of the theoretical study of disc vibrations are given by Professor Stodola in the sixth edition of his book "Dampf- und Gasturbinen," Nachtrag, page 11. The types of vibrations which occur and the apparatus used for the tests will now be briefly described. The results of these tests will also be given and a comparison made between them and those derived from the calculations.

Types of Vibrations.

(*a*) *Disc at Rest.*—First consider a disc at rest under the influence of a periodic force which acts at right angles to the plane of the disc. Forced vibrations will be induced, and when the frequency of the periodic force synchronises with the natural frequency of the disc, resonance will result and the amplitude of the vibration will greatly increase. We may divide the types of vibrations into three classes, vibrations with nodal diameters, vibrations with nodal circles, and then a combination of the two, *i.e.*, vibrations with both nodal circles and diameters. The simplest type of vibration—of an umbrella type, without nodal diameters or circles—may be caused by a faulty coupling, by vibrations in the turbine, or by the ejector action of the steam as it passes through the turbine. In practice it occurs very seldom, and it is very probable that no case of disc failure can be traced back to this type of vibration. More dangerous is the vibration about one or more nodal diameters; in fact, it is this type which is responsible for the various disc failures which have occurred. It should be noticed here that discs which are only slightly too weak vibrate

* Proc. I.C.E., vol. clxxvi.
† See, for example, "Beama," 1923, page 175.

* See "Power," vol. xlvii, No. 12, Engineering, May 20, 1921, page 631, "Turbine Troubles" from the paper by K. Baumann, "Some recent Developments in large Steam-turbine Practice."

with two, three or four nodal diameters, whilst a disc which is much too weak will vibrate about a still larger number. If the natural frequency of the vibrations of the disc be plotted as ordinates in a co-ordinate system against the number of nodal diameters as abscissæ, a number of single points are obtained. We will call the curve connecting these points the "static characteristic of the disc." As we have already pointed out, we may also have vibrations about nodal circles, and hence there will be actually a "characteristic" for each number of nodal circles. As the frequency of such vibrations is, however, so very much higher than that for vibrations without nodal circles, these higher "characteristics" do not come into consideration in practice.

The blading, by reason of its mass, has naturally an influence on the natural frequency of the vibrations, the tendency being of course to lower the frequency. If the blades are long their effect on the vibrations may be very considerable and cannot be neglected. As an example, Fig. 1 gives the "characteristics" of an unbladed and bladed disc.

In a turbine under actual working conditions the rim of the disc will be warmer than the hub; hence the natural frequency of the vibrations will be altered. For vibrations with 0 and 1 nodal diameters the frequency is increased, whereas with a larger number of nodal diameters the frequency is lowered. This can be easily explained, for, with an umbrella type of vibration, a higher temperature at the rim will tend to decrease the deflection by reason of the radial stresses outwards which are produced, whereas, the reverse will be the case for vibrations about more than one nodal diameter, an increase in the length of the rim tending to increase the deflection of the disc. In other words, when a cold disc vibrates the deformation results in either a lengthening or shortening of the rim according to the type of vibration, hence a warming of the rim will cause either a decrease or increase of the natural frequency of the vibration depending on the number of nodal diameters. The influence of the temperature distribution in the disc has been treated theoretically by Professor Stodola. He arrived at the conclusion that for each number of nodal diameters there is a critical temperature difference between the rim and the hub at which the natural frequency of vibration will fall to zero. This temperature difference corresponds to a buckling of the rim of the disc. Of course there will be a static as well as a dynamic critical temperature difference, *i.e.*, a disc at rest will buckle at a different temperature difference from that at which a rotating disc will fail.

(*b*) *Rotating Disc.*—When a disc rotates, the centrifugal forces set up may raise the frequency of vibration very considerably. For each speed there will be a different "characteristic" which may be called the "dynamic characteristic." The vibrations of a rotating disc under the influence of a fixed external force will now be considered, as, for example, is the case of discs with partial admission. Resonance will occur when the natural frequency of vibration of the disc synchronises with that of the exciting force, that is, a certain point on the disc will, after each revolution, be in the same position relative to the exciting force, or in other words, a standing wave will be produced. It will now be clear that if a wheel rotating at n r.p.m. vibrates about one diameter, its natural frequency must be n/min, if it vibrates about two diameters then the frequency must be 2 n/min, and about K diameters, Kn/min. If, then, the natural frequency of vibration of the disc about K nodal diameters is equal to Kn resonance will result. This condition will obtain if the straight line $N = Kn$, which may be called "the straight line of the excitation," cuts the "characteristic" at a whole number of nodal diameters (curve 3, Fig. 2).

As has already been seen, the "characteristic" of a disc is altered by an unequal distribution of temperature, and this may move the point of intersection of the "characteristic" and the "straight

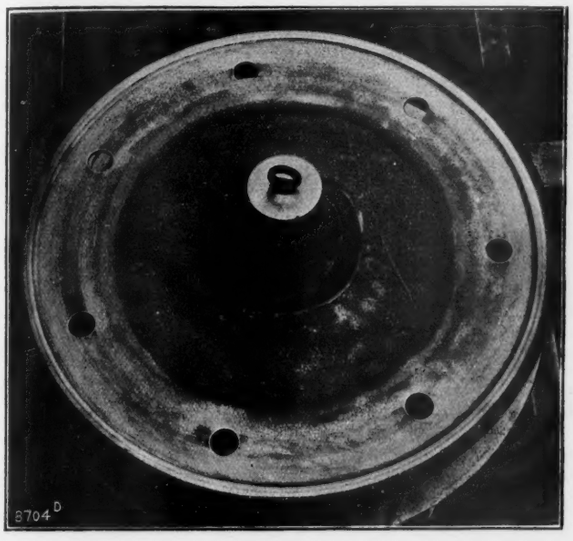


FIG. 4.

FIG 5

FIG. 6.

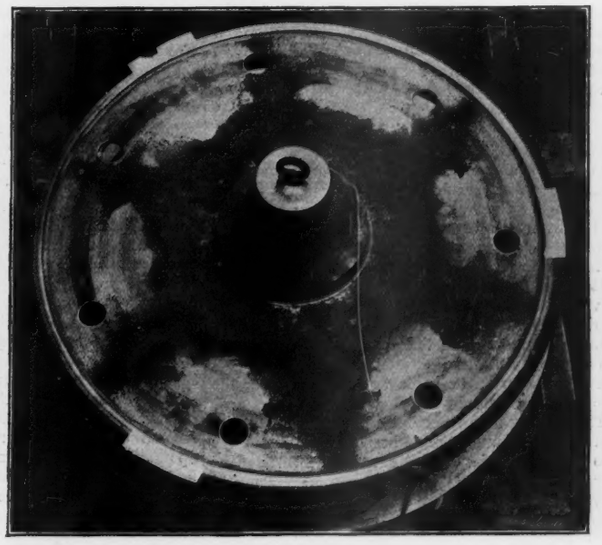


FIG. 7.

THE VIBRATION OF STEAM TURBINE DISCS.

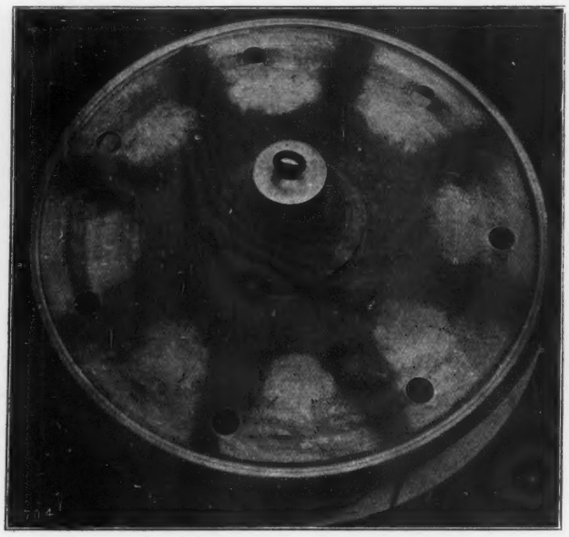


FIG. 8.

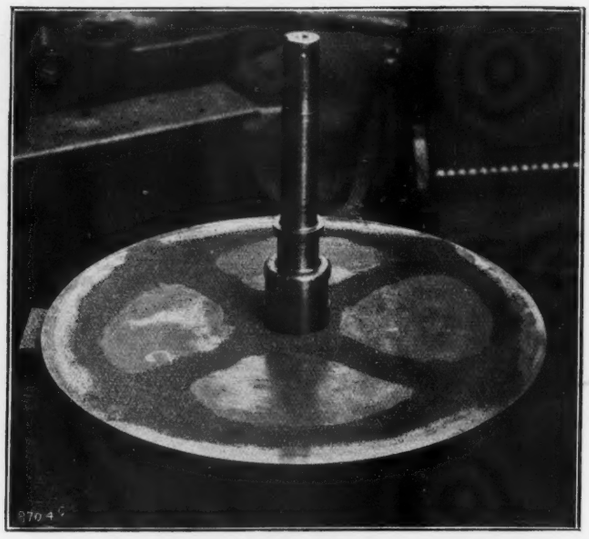


FIG. 9.

line of the excitation" from, for example, a whole number of nodal diameters to a point lying between two whole numbers or vice versâ. This furnishes us with an explanation why a wheel of a turbine may vibrate under a certain definite load, and not at any other, because at this particular load there is a certain definite distribution of temperature in the disc, at which the "characteristic" cuts the "straight line of the excitation" at a whole number of nodal diameters. If there be more than one group of nozzles, the above theory still applies, and it will be seen therefore that it is only possible to eliminate entirely vibrations in a disc by means of an alteration in the design of the disc itself and not by means of a change in the nozzles.

STATIC TESTS.

For the static tests, the disc was shrunk on to a vertical shaft and vibrations were induced by means of an alternating-current magnet (Fig. 3). By changing the frequency of the current from 0 to 150 by means of a frequency converter, it was possible to produce various types of vibrations in the discs and to determine their frequency from that of the current. In order to indicate the type of vibration sand was springled over the disc, the sand collecting over the nodes showing clearly the number of nodal diameters or circles about which the disc was vibrating.

Fig. 4 shows an umbrella type of vibration, the disc vibrating without nodal diameters.

Fig. 5 gives a vibration about 1 nodal diameter, this diameter remains at rest whilst the two halves of the disc vibrate about their plane of rest.

Fig. 6 shows a vibration about 2, Fig. 7 a vibration about 3, and Fig. 8 one about 4 nodal diameters.

Fig. 9 gives a vibration about 1 nodal circle and 2 diameters. This type of vibration could only be obtained with a very thin sheet disc and not with normal turbine wheels.

The influence of the unequal distribution of heat in a disc is shown clearly in Fig. 2. Curve 1 is the characteristic of a disc, all parts of which are at the same temperature, and curve 2 is for a disc whose rim is warmer than the hub, the temperature difference results in an increase of the frequency of vibration about 0 and 1 nodal diameter, and for vibrations about a larger number of nodal diameters, the frequency is lowered; the decrease is considerable, amounting to 20 per cent. for vibration about 4 nodal diameters.

(To be continued.)

DEVELOPMENTS IN PRINTING TELEGRAPHY.

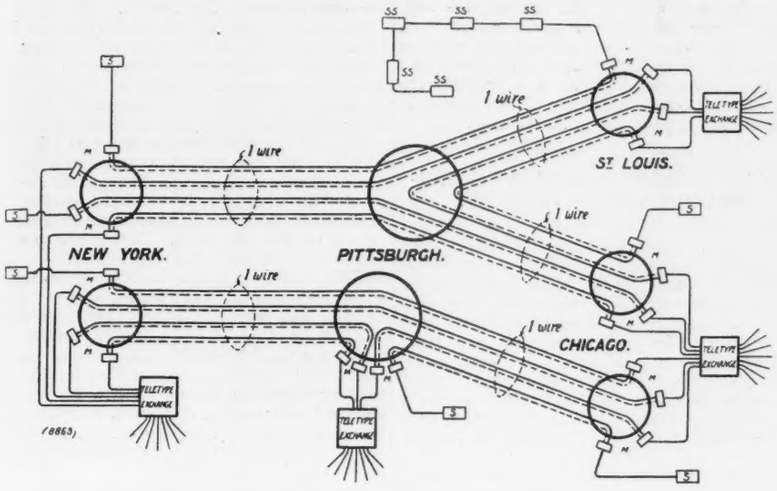
THE telephone was grafted upon the telegraph, but the two services took independent development and the new shoots outstripped the original branches. The public complains that both the services might be more reliable and less expensive, and because the ordinary citizen receives many telephone calls to one telegram, there is more grumbling about the former than about the latter. Some experts, however, consider that the telegraph is more in need of criticism than the telephone. Multiplex telegraphy is certainly a wonderful achievement; yet the telegraph wire is not utilised to the extent to which automatic telephone exchanges have enabled the telephone service to expand. Mr. Donald Murray, M.A., advocates a certain combination of the two services by the aid of "Teletypes." "The era is beginning," he stated in a paper on "Speeding up the Telegraphs: a Forecast of the New Telegraphy," read before the Institution of Electrical Engineers on December 18, "when typewriter keyboards in the office of business men will not merely type letters, but will type and transmit telegrams to correspondents in any part of the world. We should teletype as well as teletalk." He had made similar suggestions in 1911. Meanwhile a good deal has been accomplished to demonstrate that such objects can be realised.

The limitations of the telephone, as outlined by Mr. Murray, will be conceded. It leaves no records or only sound records, and requires two operators, one at each end of the line. while a loop line can only be utilised at the rate of 75 words per minute under conditions when a simple telegraph wire will admit of sending 240 words each way simultaneously, and these messages may be stored up, if necessary, at bottlenecks and despatched when convenient. The telegram has the advantage of a letter which will keep and is more quickly read than a telephone enquiry is made and listened to. On the other hand, the telegraph service is slow, costly and inaccessible while the telephone is relatively quick, cheap and accessible. These shortcomings of the telegraph Mr. Murray attributed to "defective terminal (machinery) facilities" and not to lack of circuits, which, indeed, might carry double the actual traffic. Talking and listening cost nothing—Mr. Murray forgot time and patience—the telegram requires additional instruments at both the ends. Mr. Murray likened the Morse key to the pen; the business man now had his letters typed and used the pen merely for signing, and the typewriter keyboard should be as supreme in telegraphy as it was in business, so as to link up the business man with the telegraph as with the telephone in the way the printing telegraphs, the news centres and the stock exchange tickers had done for a long time. Mr. Murray mentioned that a Glasgow broker firm paid nearly 4,000*l.* a year for a private telephone line to London; a telegraph line with adequate terminal facilities would be cheaper and prove efficient for long distances.

Applying the term "teletype" system to any combination of start-stop printers with a typewriter keyboard and telephone lines, Mr. Murray admitted that telegraph engineers would object to using telegraph machines through telephone exchanges. French experts seemed to have overcome these difficulties by the aid of valves. But separate teletype exchanges would be preferable though they might be in the same building as the telephone exchanges. The whole system would have to grow up, like the telephone itself, gradually. For the next few years there might be needed provisions only for one or two thousand teletype subscribers, in addition to a central teletype exchange at the Central Telegraph Office in London, and substations in post offices, big stores and at railway stations. A subscriber having one telephone line and a teletype would ring up the exchange and call "teletype"; he would then be plugged through and his line be cut off from the telephone; he would cut out his own telephone and have his message teletyped to its destination. A man in the country receiving at night a telegram by telephone would telephone his reply to the nearest teletype office, from which the message would go on and be found next morning by the addressee when he looked at his teletype. Farmers in the colonies would use the fence wires for this purpose already utilised for telephoning. There would be no circulation and message boy troubles, and, with the help of the sensitive permalloy cable instruments now being installed, teletyping would cross the ocean.

Teletype exchanges have already been used by the Western Union Telegraph Company, of New York, and the Bell Telephone Company, of Chicago, for some years. The Morrison Hotel, of Chicago, has installed 32 little tape teletypes representing a private exchange, and in parts the system is being applied in many countries. In London, Mr. Murray said, some firms are connected to the Central Post Office, and the Dutch Government has installed a considerable number of teletypes. There is little new in principle about the apparatus used and all are developments, some being very ingenious, of the Hughes type printers and similar devices. The start-stop printer, which Mr. Murray

advocated, is supplied in several different forms by a number of firms. How these printers are combined with multiplex printing telegraphs and teletype exchanges is indicated in the diagram, annexed, taken from Mr. Murray's paper. Two



wires are shown going from New York to Chicago *via* Pittsburg, one having a branch from Pittsburg to St. Louis. They are equipped for quadruple-duplex working. The full lines mark the four channels available in one direction, the dotted lines the four channels available in the opposite direction from the transmitting and receiving sets M. The rectangles S link these channels to the start-stop printers, and the rectangles SS further indicate start-stop printers in series, any of which may be thrown in by selective callers. A message held up at Chicago may be stayed up as a perforated tape until the line further west becomes clear again.

The start-stop printer is a telegraphic type printer which has to start and stop for each character transmitted. The old printing telegraph, relying on the continuous synchronous rotation of apparatus at the two ends, would be unsuitable for switching a machine from one circuit to another on an exchange. In the start-stop printer synchronism is required only during the one revolution that prints a letter and that can be attained on d.c. and a.c. circuits. Mr. Murray himself has worked in this field for many years and described his instruments before the Institution in 1903 and 1905. The first really successful start-stop printer, he stated last week, was brought out in 1910 by the Morkrum Company, of Chicago, and was by 1920 developed into their "teletype" typewheel, "with which the era of the new telegraphy may be said to have begun." The Kleinschmidt direct printer, the Western Electric, printer, the Creed direct printer and the Siemens-Halske "Pendeltelegraph" followed quickly, the instruments varying in capacity from 40 up to 80 words per minute; for circuits superposed on telephone lines Mr. Murray thought a speed of 40 words advisable, and 60 words for telegraph lines.

Contrary to the American, English and French experts, who rely substantially on mechanical operation, Siemens and Halske have adopted electro-automatic working in their pendulum telegraph and also in their Siemens automatic system which depends on many contacts, brushes and condensers. Though this system already links up the leading cities of Germany with London, Rome, Budapest, Warsaw, Moscow and Kristiania, &c., Mr. Murray, generally refraining from criticisms, thought that the future would assign the automatic network to the scrap heap. He prefers the Baudot alphabet (in which the average word consists of five units) to the Morse alphabet, but the charting and stop signals would bring the number up to seven units. He described the electrical and mechanical distributors and the magnet pointers of some of the instruments and did not disguise the difficulties. Some of the new instruments are designed for tape-printing, some for page; page-printing signals will print on tape instruments, but not *vice-versa*. The Western Union Company has decided to replace the old 2,000 page-printers by the simpler tape printers. It is partly a question of competition with postal telegraphs and error correction; the Western Union objects to visible corrections so that faulty messages have to be repeated, while errors in tape can be cut out.

LITERATURE.

A Hundred Years of Portland Cement, 1824–1924. By A. C. DAVIS, M.Inst.C.E.I., F.C.S. Issued in 1924 on the occasion of the Centenary of the Invention of Portland Cement. Published by Concrete Publications, Limited, Aldwych, W.C. 2. [Price 21*s*.]

IT might have been anticipated that the origin of an industry that dates back only one hundred years would be clearly delineated, and that the successive steps which marked its progress would be distinctly defined. But following the careful enquiries of Mr. Davis it would appear that the early history of Portland cement is obscure, and that throughout nearly one half of the time the progress in manufacture was uncertain and on immethodical lines. The infancy was long and delayed by rivals, known as "Roman" cement, "natural" cement, &c., and also by the failure to recognise the distinctive merits of the special form, that later was to appeal so powerfully to the engineering and building world. Hydraulic lime was prepared by Smeaton and others before Joseph Aspdin, in 1824, patented a cementitious material to which he attached, not very happily, the proprietary name of "Portland" cement. The name of Aspdin has been so long regarded as that of the discoverer, or inventor, of Portland cement, that it is right that his claim should be carefully scrutinized, and it may be said confidently that those, like the author, who have looked most critically into the early history of the cement industry, are disposed to attach very little importance to the crude efforts of Joseph Aspdin, who carried on experiments for thirteen years previous to the date of his patent, but never showed that he recognized or understood the physical and chemical basis on which the peculiar value of Portland cement rests.

Portland cement, as at present understood, implies the mixing together of calcareous and argillaceous materials, bringing them to a clinkering temperature, and grinding the resultant clinker. The necessity of a high temperature Aspdin never appreciated, nor was he fully aware of the exact proportions of the different ingredients contained in the cement he manufactured. He is fully entitled to recognition for insisting on the importance of a thorough amalgamation of his raw materials by mixing them to a state approaching impalpability, but he did not assist the art by his attempts at secrecy and the adoption of an eccentric manipulation. His service consisted in the preparation of a fairly reliable cement from materials easily accessible and cheap. His success brought other and better instructed competitors into the field, with the result that an industry that had made so little advance in centuries, now made rapid strides.

To these men, like Frost and Colonel Paston in England, and Vicat in France, the author does ample justice, but one name, that of I. C. Johnson stands out prominently by reason of his perseverance, resource, acuteness of observation, and his success in producing a reliable and uniform Portland cement. How Johnson worked and triumphed is a story over which we would wish to linger, for it is stimulating and creditable to British enterprise. We can do no more here than quote the impartial testimony of a German scientist to his merit, remembering that in the quarter of a century that separated Aspdin from Johnson, many had tried to solve the problem, but that little serious advance had been effected. Dr. Michaelis wrote in 1905: "I. C. Johnson was the first to succeed in producing reliable Portland cement in such a way that this binding agent found recognition and became generally adopted in the building trade, and him it is we have to thank that the superiority of Portland cement was recognised and worthily acknowledged."

Interesting as it is to read of these old worthies, hampered by their past experience and struggling against difficulties created by imperfect chemical knowledge, the authors' review of the history of the industry travels far outside personal reminiscences and the story of individual effort. Among the more important topics must be placed the introduction and insistence on adequate tests of the efficiency of the cement, its soundness, strength, rate of setting, and other properties. The rivalry of competitors by promoting public exhibitions had much to do with the establishment of desirable standards, and the constant investigations, voluntary or enforced, reacted beneficially on the preparation of the compound. Roman cement, "blue lias" cement, and other forms in which the ingredients were similar and similarly treated struggled hard to maintain their pre-eminence, and the fierceness of the contest is shown by the slowness with which Portland cement, properly so called, made its way against competition. As late as 1894, Mr. G. R. Burrell, in describing the cementing materials used, refers to "the new Portland cement introduced on to the market." There is other evidence of the slow and gradual advance of its use, so that half a century after Aspdin's date this cement had not established the solid reputation its merits deserved. This tardy recognition is, no doubt, an indication that much inferior cement was placed on the market under the name of Portland, that uniformity was not attained, and that the manufacture rested on no sound chemical foundation. The insistence on tests growing ever severer and more drastic with time has removed any uncertainty in quality, and the level excellence now attained in the finished cement is high testimony to the value of enforcement of appropriate standards. Mr. Davis is warranted in asserting that the standard specification is now no true indication of the excellent quality of British cement, and he states that in the near future the requirements for strength will be more stringent than hitherto.

The improvements in machinery and in the methods of manufacture necessarily receive due attention, but there is not the same necessity for entering into details, since many excellent text-books supply the necessary information. The object of the author is to show how each modification has contributed to increase the output and efficiency, and to reduce the labour and, consequently, cost of production. An early departure from the primitive methods was made by Gorham, who introduced the process of grinding by burr stones, thus permitting a thicker slurry to be used, saving a large amount of time and labour, since the slurry could be taken direct to the kilns for drying preparatory to calcination. Johnson, who rendered

inestimable services to the early manufacture, was the first to patent a method of utilising the products of combustion and waste heat for drying the liquid slurry from the wash mills, but this was as late as 1872. Shaft kilns do not appear to have been introduced into this country till the end of the century, but their advent marked a steady progress, though the kilns were operated without any mechanical appliance and the calcined material was withdrawn by hand. Finally came the rotary kiln, with which the names of Ransome and Stokes are usually connected, but earlier patents were granted to Crampton. The original attempts to work the patent were not a commercial success, but there is no necessity to dwell on the steps by which all difficulties were overcome, finally making the rotary kiln the most important means of improving the standard of quality. But the great metamorphosis worked by the rotary kiln and its accessories is in the reduction of manual labour. The whole process of manufacture has been brought very nearly to that ideal state in which automatic and continuous methods are supreme, supervision, and not labour, being required to enable the machinery to function.

The Specific Heat of Gases. By J. R. PARTINGTON, M.B.E., D.Sc., and W. G. SHILLING, M.C., M.Sc. London: Ernest Benn, Limited. [Price 30*s.* net.]

OUR age of unrest has little belief in old-established facts which re-examination not rarely finds to have been misinterpreted, if not altogether devoid of proper experimental basis, and in time-honoured constants which used to pass unchecked from one book into another. Thanks to this critical spirit, the designer has now, in the steam-world, at any rate, fundamental data at his disposal which rest on a sound theoretical and experimental basis sifted by practical experience. The engineer is less certain about his data when he has to design furnaces and internal-combustion engines, though we understand the working processes of gas engines better than those of ordinary steam engines, because we are in the former less troubled with the ever-recurring condensation of water vapour. A great deal of good work has certainly been done on the thermal properties of gases. But many of the tables are less concordant and reliable than steam data, and the figures are very inconveniently scattered over a large variety of publications. To correlate the available data and to present them in convenient form, is the object for which Dr. Partington and Mr. Shilling have compiled their volume of 252 pages on "The Specific Heat of Gases."

The reader soon sees what their task implied. The relations between pressure, volume and temperature of a gas are expressed by some so-called equation of state, which in the days of Boyle and Gay-Lussac was simply $pV = RT$. That would hold for an ideal gas; of the equations proposed to meet the conditions of actual gases the authors give fifty six. The number does not exhaust the formulæ suggested. The engineer may take his choice, and he may not share the preference which the authors seem to have for Van der Waals and Berthelot; none of the formulæ is accepted for more than a limited temperature range. Dr. Partington and Mr. Shilling explain how the specific heats are determined; they discuss the effect of temperature and pressure upon the specific heat, further heat of formation, Nernst's heat theorem and dissociation, and they thus prepare the ground for presenting their 20 pages of specific heat tables, which deal with gases in general and with steam and the ordinary constituents of the atmosphere in particular. In the general tables they give all the values of accredited experimenters, recalculated and corrected; their molecular heats of steam are based upon the formulæ of Callendar and of Berthelot. The last chapters, V. and VI., of the volume deal with applications of specific heats to internal-combustion engines, furnaces, gas producers and refrigerators, and with the theory of the specific heats.

The volume is neither a text-book, nor a theoretical memoir. It is a useful reference book, written for the expert who has to perform thermodynamical calculations and wishes to understand the data and formulæ he uses. It is conveniently arranged for that purpose. Most of the many names and papers to which reference is made in the text for further information, are collected together in the 8 pages of bibliography. There is also a subject-matter index; but a name is frequently looked up more easily than the various headings under which a subject might be entered. Dr. Partington, a well-known worker in the field of thermodynamics, entitled to his own opinions, has repeatedly occasion to quote himself and his collaborator. The volume will be widely appreciated, as it is probably the first coherent critical summary of this branch of thermodynamics published in this country.

WATER-POWER PLANT AT FORS-HUVUDFORSEN, SWEDEN.

THE World Power Conference held at Wembley in July last, which was fully reported in these columns at the time, was notable for the amount of prominence given to matters relating to water power. In these sections among the more interesting contributions, were those of engineers from Norway and Sweden. Representing the latter country in the section devoted to water power engineering, Mr. A. Westerlind read a comprehensive paper dealing with recent developments in Sweden. This, as Mr. Westerlind is a chief director of the Royal Board of Waterfalls, of Sweden, was not unnaturally largely devoted to details of recent State installations, though notice of others was not overlooked, one private undertaking only lately completed being several times mentioned. We refer to the Forshuvudforsen plant on the Dalälven, constructed to the designs of the Vattenbyggnadsbyran, consulting engineers of Stockholm. This plant possesses numerous interesting features, and illustrates the latest Swedish practice in a number of directions to which notice was drawn at the World Power Conference. Among these may at once be mentioned the use of large roller dams, the arrangements of fish screens and trash racks, and the prevention of ice troubles at the racks, sluices, &c.

The Forshuvudforsen plant is owned by the Stora Kopparbergs Bergslag Aktiebolag, of Falun, Sweden, and for the following account of it we are mainly indebted to Mr. M. Serrander, C.E., a director of this company, and a prominent member of the Swedish Water-power Association. Before embarking upon a description of the new plant it will be interesting to give some account of the activities of the company owning it.

The Stora Kopparbergs Bergslags Aktiebolag derives its name from the ancient copper mine at Falun—Stora Kopparberget (The Great Copper Mountain)—in the province of Dalecarlia. The mine was worked as early as the thirteenth century, and from the industrial enterprise connected with this mine, has sprung the present concern which may be said to date from about 1285. Thus, the Stora Kopparberg Company may claim to be one of the oldest businesses in existence.

For many centuries the firm was the largest producer of copper in the world. Gradually the enterprise was expanded to include other industries, which at present constitute its main source of prosperity. *i.e.*, iron and steel, forestry and sawmilling. As early as 1735 its first iron works were built at Svartnäs in Dalecarlia, and in the course of time a number of other works were acquired or built, so that towards the end of the nineteenth century the company possessed about twenty small blast furnaces and iron works in Dalecarlia. About 1870 steps were taken to concentrate the company's iron industry at one of the greater waterfalls on the Dalälven (Dal River), where there are now up-to-date works at Domnarvet; these are the largest in Scandinavia. Most of the small works were then shut down. During the present century, the company has acquired several of the works which obtain their supply of iron ore from the famous Dannemora mines, viz., the Gysinge electro-steel works, the Söderfors works for carbon tool-steel and high-speed steel manufacturing, and the Älvkarleö works for the manufacture of steel springs, as well as some minor works. The raw material for this extensive industry is obtained from numerous iron mines, owned by the company in the mining districts of Central Sweden. The most important of these mines are located in the great Grängesberg ore field, about half of which is the property of the company, in the ore-field of Blötberget and in the above-mentioned Dannemora field. All these mines of the company, except the Dannemora mines, are worked also for export of ore.

The timber trade of the company is now based on the possession of a productive forest area of about 350,000 hectares (865,000 acres). Its first sawmill was erected in 1689 at the site which is now occupied by the Domnarvet ironworks. After the erection of several minor sawmills at various places, centralisation was also effected in this branch of the business during the latter part of the nineteenth century. About 1890 the main part of the sawmilling trade of the company was transferred to the Skutskär sawmill near the mouth of the Dal river. During the past few years the company has erected another large sawmill at Byssjön in the vicinity of Domnarvet. In connection with other branches of the timber industry the company, about 1890, also erected woodpulp and paper mills, namely, sulphate and sulphite mills at Skutskär, and a mechanical pulp mill, paper mill and sulphite mill at Kvarnsveden. Side by side with these activities, an important chemical industry has developed, comprising such products as pyrites, sulphuric acid, sulphate of copper, sulphate of iron, sulphate of alumina and acetic acid.

The power required for all these works is now being supplied almost entirely by the company's own water-power plants on the Dal and adjacent rivers. The water-power owned by the company amounts at present to about 200,000 h.p., half of which has up till now been utilised.

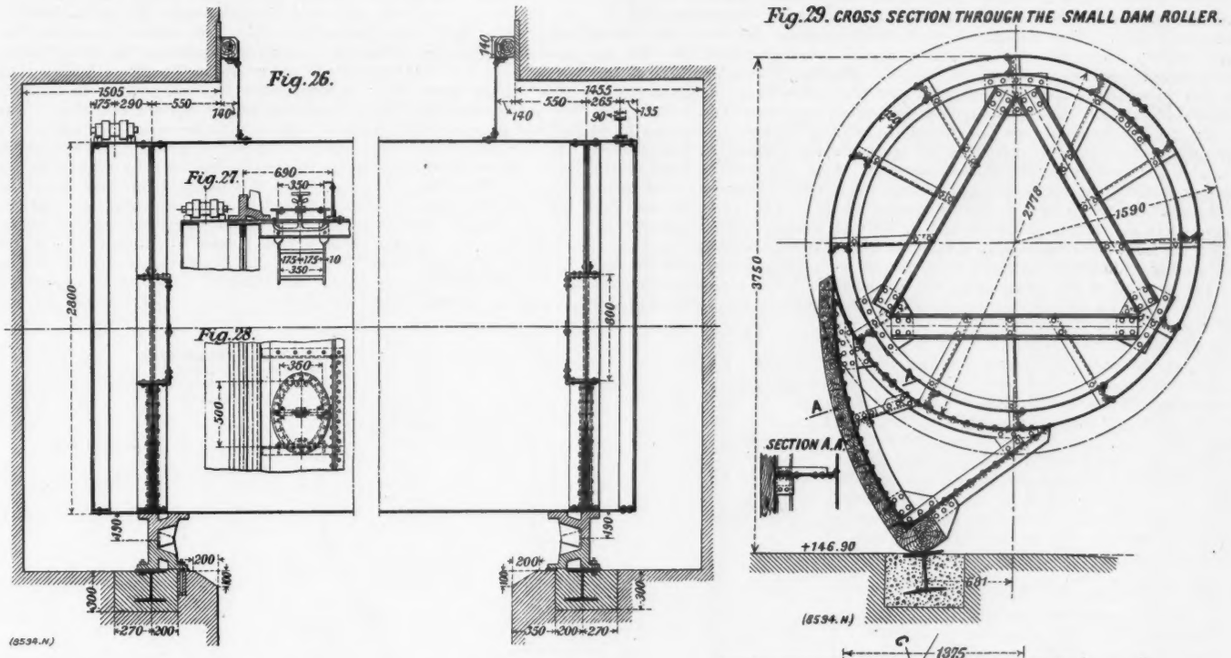
The first large water-power plant was constructed as early as about 1870 in connection with the erection of the Domnarvet iron works. The paper mill at Kvarnsveden was also located at a waterfall on the Dal river and a large electric power station was erected at this place. In order to meet the increased demand for power, an important electric power plant with a capacity of 20,000 kw. was constructed in 1907–10 at the Bullerforsen falls on the Dal river, near Domnarvet. For its lumber mills at Skutskär the company utilises the power supply from the big State power-plant at Älvkarleby, the company being one of the riparian owners at the Älvkarleby falls.

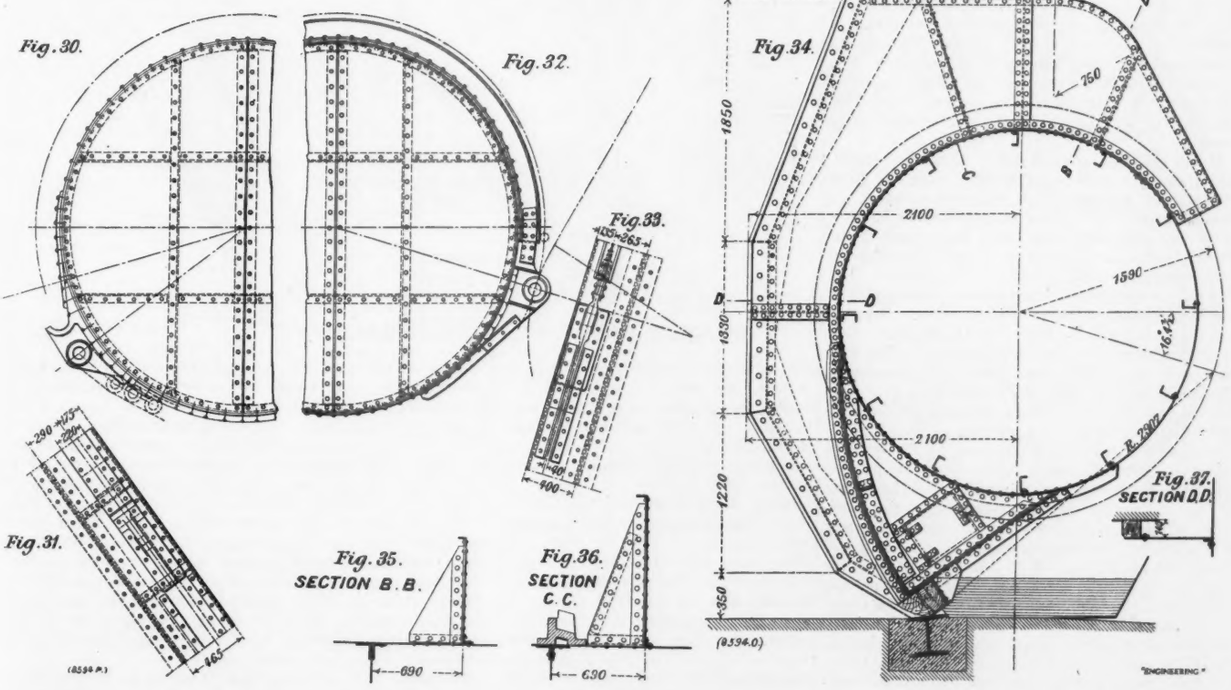
All these and other power plants were soon fully utilised, and in 1917 it was necessary for the company to take preliminary measures with regard to the erection of another big power plant on the Dal river, at the Forshuvudforsen rapids located 5 km. (about 3 miles) above the Domnarvet ironworks.

The plans for this new plant included the construction of a dam across the river just below the rapids, with a power house placed at one end of it. The water level has been raised 10·5 m. (34·5 ft.) by means of this dam. Drawing from the storage thus formed, in accordance with the daily and weekly variations of the load the power station utilises up to 210 cub. m. (7,417 cub. ft.) per second out of a total flow varying from 50 cub. m. to 2,000 cub. m. (1,770 cub. ft. to 71,000 cub. ft.) per second. The catchment area is 21,000 sq. km. (8,100 sq. miles). The surplus flow is discharged through the dam, which is provided with four large sluice openings, each 17 m. (55·8 ft.) wide, which are closed by rollers. The power house contains three generator units with auxiliary machinery and switch gear. Each turbine has an output of 5,200 kw., with a head of 10·3 m. (33·8 ft.), and a speed of 83·3 r.p.m. Two views taken from the down-stream and up-stream sides of the dam are given in Figs. 1 and 2, Plate I, while drawings showing the structure and power house in elevation and plan, are shown in Figs. 3 and 4.

The most interesting features of the dam consist in the rollers and the method of operating them. Two of the dam rollers have a height of 8·85 m. (29 ft.), a third has a height of 6·25 m. (20·5 ft.), while the fourth has a height of 3·75 m. (12·3 ft.). These different sizes have been adopted with a view to facilitating the utilisation of the water required for floating logs past the dam. While the dam

DETAILS OF SMALL ROLLER AT FORSHUVUDFORSEN DAM, SWEDEN.





rollers of this installation are not the largest in respect of span, so far adopted, the two large rollers have a greater height than any others so far installed. Other comparative installations are quoted in the following table:—

	Free Span. Ft. In.	Height. Ft. In.
Forshuvudforsen ...	17 m. (55 9¼)	8·85 m. (29 0)*
Trollhättan... ...	20 m. (65 7·4)	4·0 m. (13 1·5)
Alvkarleby... ...	20 m. (65 7·4)	2·8 m. (9 2·0)
Lilla Edet	22 m. (72 2·0)	3·8 m. (12 5·6)
Porjus	12 m. (39 4·4)	3·5 m. (11 5·8)

* Two largest.

We are able in Figs. 5 to 25, on Plates II and III, to give various drawings and views of the dam rollers at Forshuvudforsen. The drawings, Figs. 5 to 20, which are given on our two-page Plate II, relate to the two largest rollers, while Figs. 26 to 37, above, are of the smallest. The intermediate-sized roller is a modified form of the largest size. Of the views reproduced in Plate III, Figs. 21 and 24, show the largest size of roller. Fig. 22 illustrates the intermediate size roller, while Fig. 23 is a view of the smallest which is again to be seen in the immediate foreground of Fig. 25; this view also shows water passing under the intermediate-sized roller, the two largest being accommodated in the bays in the distance. Further details are given in the illustrations on pages 8 to 10. To these we shall refer later. The three largest rollers consist of a deep flash board curved towards the bottom and supported by bracing from a main girder taking the form of a cylinder. In the smallest roller the flash board projects in a tangential manner from the cylinder itself, from which the lower part is supported by means of struts. This portion of the flash board is curved like the lower part of the large rollers.

The rollers are operated by means of chains wound round one end of each. On these being drawn in, or paid out, the roller is revolved, and moves up and down on inclined racks, the teeth of which mesh with teeth on rack segments fitted to the roller ends. The water pressure on the flash board and the weight of the roller result in turning moments around the horizontal rolling

axis, which, on operation, have to be overcome by the hoisting machinery. The values of these moments depend upon the profile adopted for the flash board, and the arrangement of the hoisting racks and gear. The design adopted for the large rollers, built by the M.A.N. Company, Gustavsburg, Germany, is shown in Figs. 5 to 20. In this particular instance, at the moment the roller leaves the sill the turning moment required is only 60 per cent. of the maximum required during the lift, leaving a margin of 40 per cent. available for overcoming abnormal resistance at starting, due, for instance, to the roller being frozen to the sill. The main lines of the structure of the large rollers are shown in Figs. 5 and 6. Of the latter, the right-hand part shows the end at which the hoisting chain is fitted, the left-hand part showing the free end of the roller. Fig. 7 is a general drawing showing a section through one of the large roller bays. Fig. 8 is a section taken across the centre of the roller while Figs. 9 to 11 show details of the end plating at the hoisting end, Figs. 12 to 15 giving details of the free end. The cylindrical girder, Fig. 8, is 3·0 m. (9 ft. 10 in.) in diameter, and is built of plating 18 to 27 mm. thick and stiffened with longitudinal channels of 180 mm. × 70 mm. section, the web being 8 mm. and the flanges 11 mm. thick. These channels are connected at intervals of about 1·725 m. (5 ft. 7·8 in.) by angle rings strutted by triangles of channels, from which also angle-iron struts extend out to the longitudinal stiffeners on the shell. The flash board is of plating 11 mm. (0·43 in.) thick, supported on a framework of vertical channels 1108 mm. (3 ft. 7·7 in.) apart, with strong horizontals at the top and bottom edges, and a number of intermediate horizontal channels. The struts to the cylindrical girder are for the most part of channel section. The lowest members are composed of two channels back to back, spaced slightly apart. The uppermost consist of two channels close together. For the rest the three lower struts are single channels, while the upper are of double angles. These are all coupled to the cylindrical shell by large angle gussets.

On an extension at each end of the main cylinder, and working in a recess, is fitted a large end plate carrying the segmental rack, and around which are passed chains. At the hoisting end, this end plate is circular and rather more than 6·6 metres (21 ft. 7·8 in.) in diameter, the pitch circle of the segmental rack being 7·0 m. (22 ft. 11·6 in.) in diameter. The end plate is strongly stiffened outside the cylinder by radial gussets supported by angle irons. Between the points K_1 and K_3, Figs. 9 to 11, the plate itself is stiffened by cover plates on both sides. This is at the point where the segmental rack commences. The rack extends from K_1 to K_6, Fig. 11. The hoisting chain is attached to a forked hook-shaped mounting riveted to the plate rim at K_{13}, Fig. 11. The chain extends round the drum in the opposite direction from the rack, and leaves it parallel with the fixed rack on the piers, this being set at an inclination of 60 degrees to the horizontal. Both end plates are furnished with segmental racks, the arrangement at the free end being shown in Figs. 12 to 15. At this end the large radius circular arc is restricted to that portion fitted with the rack, and for the rest of the circle, the end plate is reduced to a wide ring well stiffened by gussets and giving support to the rack section. As in the case of the hoisting end, stiffening plates are fitted on each side of the end plate at the commencement of the rack. Outside the flange on which the rack is fitted, is an extension supported by deep gussets (Figs. 13 and 14) where a check chain is fitted. This unrolls as the roller is lowered, and works over the same segment, K_1 to K_6, Fig. 12, to which the rack is fitted. It is fitted to the roller by means of the eye shown in Figs. 12, 14 and 15, the other end being fixed to the pier near the top of the fixed rack, in the manner shown in Fig. 22. This check chain is only provided to ensure the free end of the roller meshing correctly on being hoisted by the movement transmitted from the other end.

The flashboard is sheathed with heavy timbers for a depth of 3 metres above the sill. The roller structure is also protected on the underside by open planking of 60 mm. (2·36 in.) thickness. Similarly, on the upper side there is a covering of open 40 mm. (1·58 in.) planking. These are shown in the details attached to Fig. 8. At the bottom edge of the flashboard is a timber seal resting upon a dressed granite sill. The side seals are interesting. They consist of 150 × 150 mm. (5·9 × 5·9 in.) quartering mounted on flexible wing plates 8 mm. (0·31 in.) thick. On the inner edge the latter are fixed to the flashboard end frames, and the pressure of water forces the quartering seals up against the sides of the piers. These details will be followed by reference to Figs. 16, 17 and 20. The seals, as will be seen from Figs. 6 and 16, work against surfaces outside the recesses in which the cylinder ends and racks are accommodated.

Having described the large dam rollers at such length the features of the smallest one will be easily followed from Figs. 26 to 37, on page 7. Of these

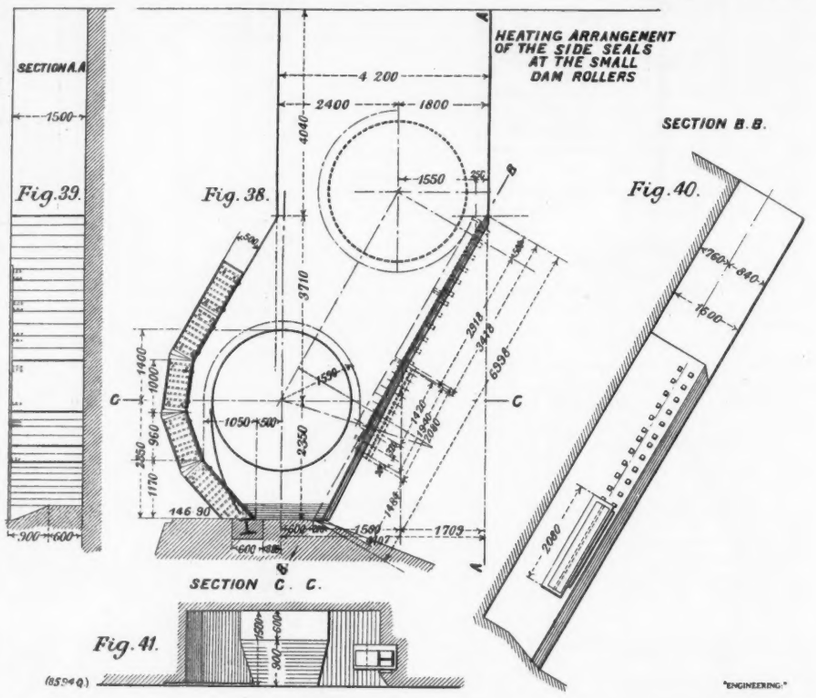


Fig. 26 shows a longitudinal section and illustrates particularly well the arrangement of the ends within the recesses in the piers, and the manner in which the side seals bear up against the pier walls. The cross section, Fig. 29, shows that the sill in this case is a rolled steel joist set slightly canted in a bedding of concrete. The internal bracing of the cylindrical main girder follows the lines of that adopted for the large rollers. The two ends are shown in Figs. 30 to 33. The two first of these show the attachment for the chain at the hoisting end. The two last show the free end and arrangement for the check chain. Figs. 34 to 37 show the arrangement of the side seals for the small roller. A section, Fig. 37, illustrates the actual seal, and flexible plate 5 mm. thick on which it is mounted, Figs. 35 and 36 showing simply the wing plates and gussets supporting the seal plate on the upper side.

The two largest rollers weigh each 141 tons, the intermediate sized roller weighs 89 tons, and the smallest 40 tons.

The illustrations, Figs. 42 to 46, on page 9, show the racks for the large rollers. At the lowest part, for a length of 3·64 m. (11 ft. 11 in.) the teeth are 250 mm. (9·8 in.) wide. For the remainder they are only 150 mm. (5·9 in.) in width. The shape of rack and teeth has been specially designed with a view to pressing out any ice that may form in the spaces between them.

Several papers read before the recent World Power Conference referred to measures taken in Sweden and Norway to guard against ice troubles in connection with the operation of hydro-electric plants. The steps taken at Forshuvudforsen in this respect are particularly complete. In the severe winter weather the proper maintenance of the side seals is indispensable for the satisfactory working of the rollers. Experience has shown that if the pier facings are not heated the water leaking through will freeze at these parts to form a ridge of ice, which pushes the seal away from the wall. The ice forming on the bottom and sides of the recesses in which the roller ends work and on the racks, &c., will under such conditions accumulate so rapidly that its removal may cause a great deal of trouble. For this reason in the case of the two smaller dam rollers at Forshuvudforsen cast-iron plates are let into the pier faces covered by the side seals. These plates are hollow and in the cells in their interior are placed electric heating elements. The elements consist of an alloy resistance wire enclosed in watertight boxes. For the regulation of the heat the elements are connected in parallel or in series by groups, so that heating may be limited to any part of the surface where it is required. The arrangement is shown in Figs. 38 to 41, above. The smallest roller takes when under full current 10·6 kw., and the larger one 19 kw., the pressure being 110 volts. In order to discourage the formation of ice, hot air from the generators in the power station is distributed through ducts in the dam masonry structure. A main duct passes under the dam sill and branches are carried up through the piers and terminate at the upper end of the roller recesses in a hinged pipe mouth, to be seen in the recess in Fig. 23. By these the warm air is directed to the underside of shields attached to the roller ends.

The sill levels vary, of course, for the various sized rollers, and the actual sectional profile of the dam at the sluices is, naturally, adapted to suit these conditions. The dam is founded on rock and is built of plum concrete into which are tied, by steel rods, large facing stones of granite. These are also keyed together by steel bars. The base and the core of the piers are of plum concrete with reinforcement, these parts of the structure being completely faced with dressed granite. The piers are tied to the dam structure proper by means of a number of long steel bars. The apron on the lower side is of concrete, faced with timbering.

The hoisting gear for the four rollers is concentrated in two groups, and accommodated in two overhead structures, as will be gathered from the general views and drawings, Figs. 1 to 4. The

HOISTING ARRANGEMENTS OF DAM ROLLERS AT FORSHUVUDFORSEN, SWEDEN.

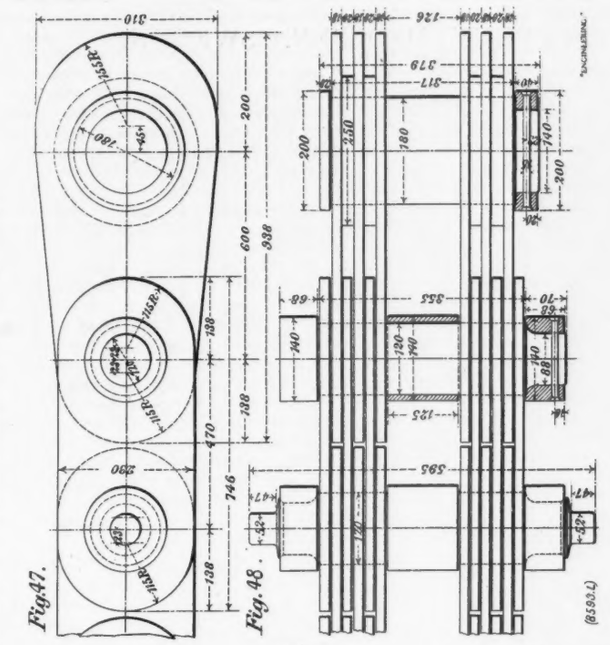


Fig. 47.

Fig. 48.

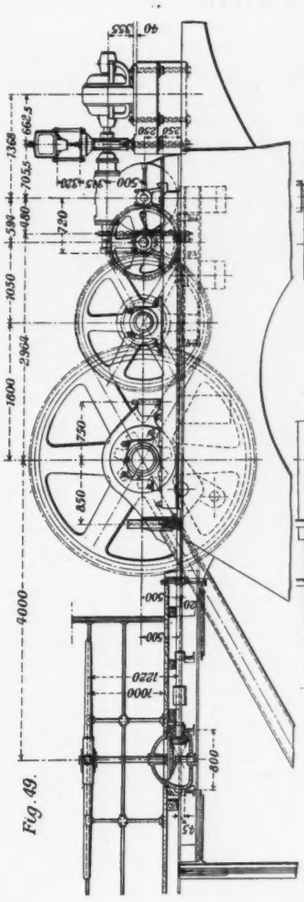


Fig. 49.

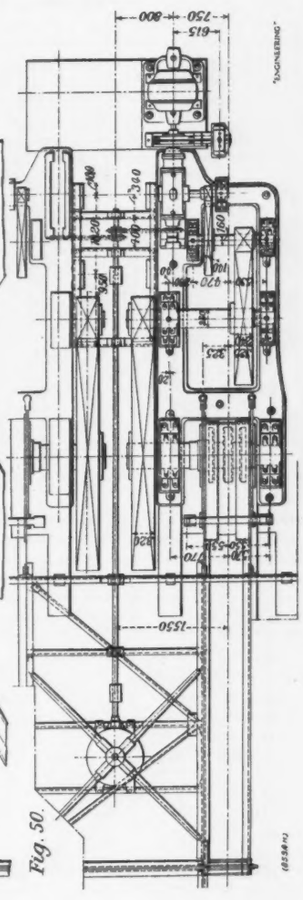


Fig. 50.

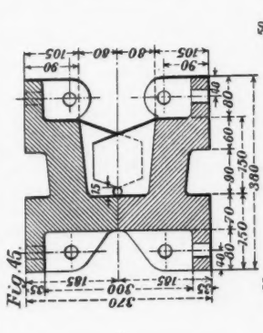


Fig. 45.

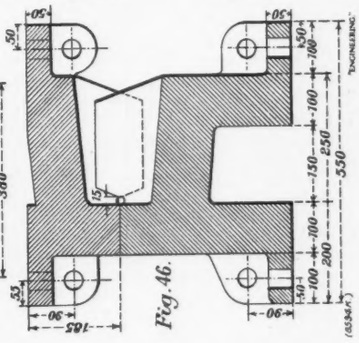


Fig. 46.

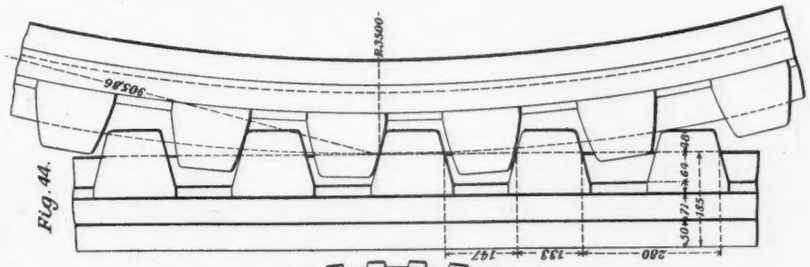


Fig. 44.

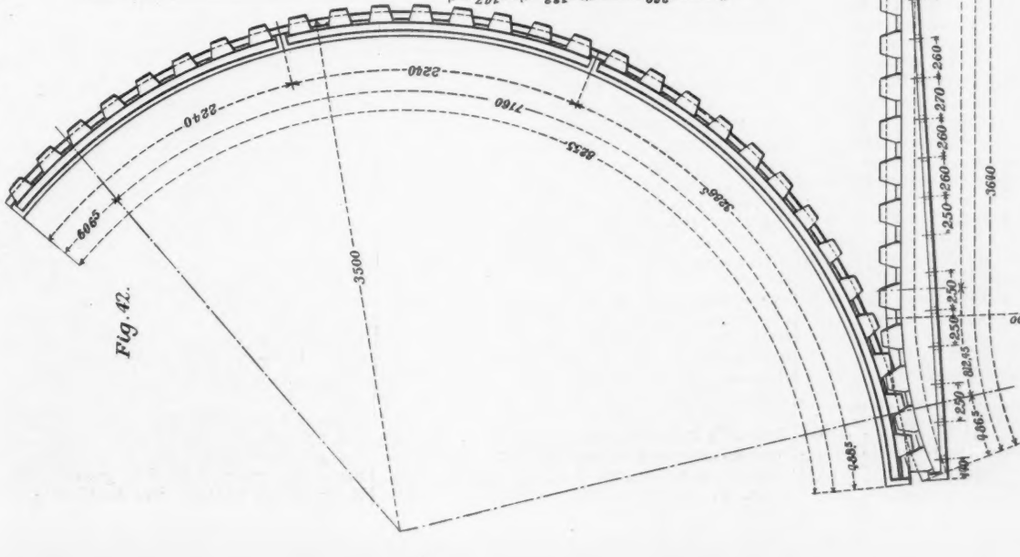


Fig. 42.

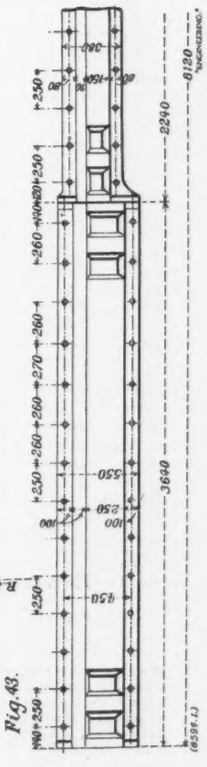


Fig. 43.

WATER POWER PLANT AT FORSHUVUDFORSEN, SWEDEN.

Fig. 51.

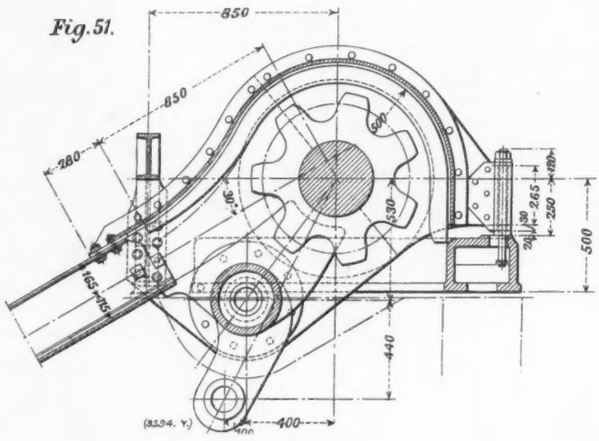


Fig. 52.

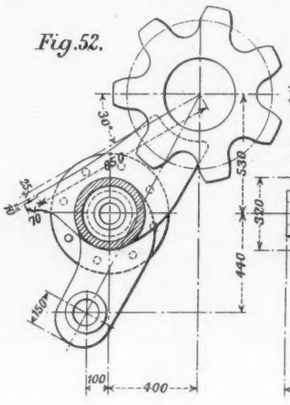
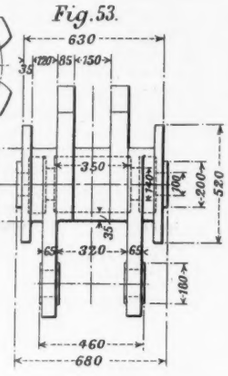


Fig. 53.



arrangement is also well shown in Figs. 7, 21, 22 and 25. These winch houses are wooden buildings with roofs of self-supporting dome construction. They are carried on reinforced concrete platforms, which are in turn raised above the pier coping level on four double legs of reinforced concrete, two of which are nearly vertical, while the others are set at an angle corresponding to the direction of pull on the chain.

Figs. 49 and 50 show the hoisting gear for the large rollers, the plan Fig. 50, showing part only of the second set of the pair. The gears are electrically driven through clutches and self-locking worm and spur reduction gears, the hoisting chains being wound in over triple sprockets and led off down a slanting chute. The large rollers have 32-h.p. motors, and at the chain these are designed to exert a pull of 130 tons. The pull of the gear for the intermediate roller is 80 tons, and for the smallest 45 tons. The gears can also be operated by hand, by capstan bars on a platform, from which the drive is taken by bevels and shafting to sprockets and chains operating the worm of the first reduction gear.

The hoisting chains are of the Gall type, with improvements introduced by the M.A.N. Company. Typical links are illustrated in Figs. 47 and 48, which show, to the right, one of the end pins and links for attachment to the rollers. The pins are fitted with bushes, the normal pin being similar to that shown on the left of the plan, Fig. 48, but without the small heads projecting beyond the outside bushes, which are only used for the run of the chain in the guide when led off the sprockets by means of a stripper supported by the shaft. The sprockets and stripping gear are shown in Fig. 51, above, Figs. 52 and 53 showing the stripper itself. On the latter are two arms projecting upwards between the sprocket wheels. The arms are curved so that the chain on leaving the sprockets is led into the chute. The stripper, in addition, has two arms projecting downwards. To these, long links may be attached, their bottom ends being coupled by a pin which can be passed, when the roller is raised and it is required to be held in its highest position, under a hook to be seen in the drawings illustrating the free ends of the rollers. The lifting chain can in this way be relieved of its load. In the case of the large rollers the gear takes up 0·28 mm. (0·011 in.) for each revolution of the motor. The motor is operated by three-phase current at a speed of 720 r.p.m.

(To be continued.)

THE STUDY OF ELECTRO-METALLURGY.—A course of lectures on electro-metallurgy will be given by Mr. H. M. Chapple during the second and third terms of the session 1924–25 at The Sir John Cass Technical Institute, Jewry-street, Aldgate, London, E.C. The course will be supplemented by laboratory work, and the opening lecture will be delivered at 7 p.m. on January 8, 1925.

INSTITUTION OF MECHANICAL ENGINEERS: MANCHESTER MEETING.

AT a meeting of the North Western Branch of the Institution of Mechanical Engineers, which was held in the Engineers' Club, Manchester, on Thursday, December 18, two papers were considered, one being on "The Effect of Low and High Temperatures on Materials" (see ENGINEERING, vol. cxviii, page 816), by Professor F. C. Lea, of Sheffield University, while the second, on "The Elastic Limit in Tension and its Influence on the Breakdown by Fatigue" (see ENGINEERING, vol. cxviii, page 813), was introduced by Professor B. Parker Haigh in the absence of the author, Mr. J. M. Lessells, of the Westinghouse Research Laboratory, Pittsburgh, U.S.A.

In opening the discussion Mr. W. E. W. Millington said that he had great difficulty in understanding many parts of Mr. Lessells' paper. Only after reading five pages of the paper was it possible to obtain any sort of insight into what elastic properties were dealt with by the author, who was evidently taking the limit of proportionality and describing it as the elastic limit. It must not be forgotten that these were essentially different, as had been shown by Dr. Thompson and himself (the speaker). Mr. Lessells stated that attempts had been made to show that the endurance limit or true elastic limit was related to the ultimate stress in tension alone. Apparently he had got in his mind that there was an endurance limit in fatigue, and that it was the same as the elastic limit. If it were so, why did he not find the true elastic limit and have done with it. It was stated by the author that "a low elastic limit value meant a low endurance limit value." If that were so, in the case of copper, for instance, where the elastic limit was almost zero, he asked, why did they not get a fatigue limit of zero, instead of the usual high value.

He agreed with the author that the deflection method of determining fatigue was not reliable. It certainly gave some indication, but not complete information on the fatigue limits. Dr. Thompson and he had shown that the earlier stages of plastic deformation depended upon the atomic structure of the material, the internal stress in the material, the grain size of the material, and also very definitely on the amount of free surface of the specimen as compared with the area of the section, as well as the stress distribution, whether it attained a maximum on the surface, or whether it was equally distributed over the section. They had shown quite definitely that all these factors entered into the consideration of fatigue, and until their effects were appreciated, he did not see that it served any useful purpose to try to correlate the endurance limit with individual physical properties, especially when no notice was taken of the enormous difference in the atomic structures of the different materials.

Dr. F. C. Thompson, referring to Professor Lea's paper, said the author had done an extraordinary amount of very valuable work on the effect of high temperatures on metals. He had extended this work in the present paper to cover, to some extent, the effects of low temperature. So much work had now been done on high temperature actions that the elements of the ground had been adequately covered, and yet it could hardly be claimed, except in connection with the creep tests, that very much more than the elementary questions involved had been dealt with. The subject of creep was certainly as important as Professor Lea had made out. But the rather astounding statement was made that his technique was novel. That was not the case. Dickenson had published a most valuable paper in the Journal of the Iron and Steel Institute two or three years ago. Even that did not limit the work which had been done. A good deal of work had been done in France, and some investigations were made in America. One point might be taken. Quite obviously, valuable knowledge with regard to creep was really only obtainable in tests extended over a very long time indeed, and not in a few hours. Professor Lea had shown a slide giving results obtained in a test of 35 days' duration, but Dickenson had carried his tests very much longer, and some stresses were maintained constant for 250 days. Professor Lea had spoken about the solidification of viscous material. If that had any meaning at all, it was simply stating in other words the idea of the temporary mobile film. That hypothesis had never been generally accepted, and had now been definitely proved to have no true basis by leading metallurgists. It had also been disproved by an engineer, and the work of Mr. Gough at the National Physical Laboratory was absolutely incompatible with the belief. He had from time to time had several cases of material at high temperature—about 200 deg. C.—in which failure could not be explained. The engineer had been satisfied with the design. The microstructure had been satisfactory, and the analysis had been satisfactory, and the only possible explanation was that some curious and insignificant critical point had a very real importance to the engineer. It would be much more valuable in dealing with very slow processes if sufficient information could be obtained to determine on what physical property these actions depended, rather than that work which had already been done should be repeated.

Mr. Bailey said he wished to endorse the remarks which had been made in reference to Dickenson's work. In his own work he had attacked the subject of temperature effect from a different point of view from Dickenson. He had started with a definite stress, and then, working at different temperatures, had obtained the life of the material. He had thus got his results on a basis of temperature against time. The whole of his data gave straight lines. No indication whatever was found of any stress

being reached at which they could say creep would not take place. If the time taken for a material to reach a suitable condition at high temperatures was to be obtained, it should be done by means of very delicate apparatus, and the test conducted for a considerable period of time. He thought that there was a very important reason why one could assume that creep would proceed at elevated temperature. He had formed the impression that the hypothesis suggested was based upon the tests made at 350 deg. C. Very considerable changes took place above that temperature. The endurance curves given by the author showed that there was evidence of a critical change taking place in the region of 300 deg. to 400 deg. C. He therefore doubted whether the hypothesis proposed in the paper would be applicable above a temperature of 400 deg. This brought out the importance of the metallurgical examination of the material in addition to the other tests. If important thermal changes were taking place, the action of creep would only be thoroughly understood when they had co-operation in test work between metallurgists and engineers. It was interesting to refer to the high-tensile steels and alloys that were being developed at the present time. The whole tendency seemed to be to produce alloys of the solid-solution type and of high melting-point, and not subject to thermal changes, as in the case of steels of ordinary composition. For that reason, he thought that micro-photographs would be a useful addition in a paper of that kind.

In referring to Mr. Lessells' paper, he said, the important point the author drew attention to was the fact that the yield-stress method of determining the limit of the material was not as promising as they had thought. Fatigue tests, on account of the time occupied, could only be of a laboratory character, and could not be conducted for commercial purposes. When Mr. Gough suggested that by the deflection method they could obtain the fatigue-stress limit of a material in 20 minutes or less, engineers had some hope that they were going to get over the troubles. That method did not seem, however, to be reliable, judging by the data they already had, but it would be a very good thing if further information could be obtained on that point. Mr. Lessells stated that his formula was based on a similar microstructure, but it was noticed that the steels used gave a range of carbon-content from 0·37 to 1·2 in the normalised condition, and one would not regard those steels as having similar microstructure.

Mr. Buttenshaw confined his remarks to the questions discussed in Mr. Lessells' paper. It seemed to him that an attempt to correlate fatigue experiments with a so-called elastic limit or limit of proportionality on the strain diagram was futile. The only test which appeared to bear any relationship to fatigue failure was the ultimate tensile test, with the possible exception of the Brinell hardness test. The recent work of Professor Thompson and Mr. Millington, as set out in a paper read in May, 1924, before the Iron and Steel Institute, showed that a consideration of the deformation of the space lattice was of prime importance. The authors of that paper had also shown the importance of surface effect on the specimen, which was admitted by Mr. Gough, and also the effect of grain size, so that it would appear that the line of attack, when considering fatigue failure, should not be to compare endurance limits with any such vague properties as elastic limits or limits of proportionality, but rather to take into consideration the factors which Messrs. Millington and Thompson had shown to be of such importance.

Professor W. Mason thought that the only novelty in Mr. Lessells' paper was his attempt to take into account initial internal stress in material tested for the fatigue limit. It was well known from the work of Haigh, Aitchison and others that the fatigue limit (with equal plus or minus stresses) and the "ultimate" stress in tension were correlated, the ratio of the former to the latter lying generally between 0·4 and 0·55, but was for any one kind of metal between narrower limits. Gough and Hanson suggested (Proc. Roy. Soc., 1923, page 556) that this correlation followed from their contention that failure under repeated stress and failure in static tension were preceded by the same process, and that the mechanism of failure was similar. Mr. Lessells suggested that a better correlation might be established by taking into account internal strain as evidenced by the ratio of the yield point to the proportional elastic limit determined in static tension. He called this ratio x and found, on limited evidence, that kx is more nearly constant than k, k being the ratio of ultimate stress in tension to the endurance limit. Mr. Lessells might have put his argument upon a broader basis by making tests upon cold-worked steel, which, of course, would have large internal stresses. Mr. Lessells did not mention any particular precautions taken in obtaining his static elastic limits, although variations in the results must be anticipated if the pull were not made truly axial.

Continuing, Professor Mason said Professor Lea had pointed out the practical significance of "continuous creep." For high temperatures "ultimate stress" must be replaced by the idea of "stress for continuous creep." We had a similar notion in the compression loading of some ductile metals, where at ordinary temperatures an ultimate stress was supplanted by a "pressure of fluidity." For high temperatures the tensile-stress-strain diagram had to be superseded for each temperature by a stress-time-strain diagram. Professor Lea had not, he thought, been happy in the use of the term "viscous." He did not think it necessary to labour this point, but suggested that recent information on the mechanism of creep and elastic strain really precluded the use of the term "viscous": the term led to misapprehension and, perhaps, confusion. He asked Professor Lea if he would describe the metal passing through a die in the process of wire-drawing as temporarily viscous and whether cast iron could under any stress be described as continuously or temporarily viscous. For want of a better word, they should stick to the term "creep."

Professor Haigh said it was perhaps easy to find points in Mr. Lessells' paper that merited rather adverse criticism. He would like, if he could, to add to the discussion in an instructive manner rather than to refer to obvious weak points in the paper. He thought that Mr. Lessells had earned their gratitude in bringing to their notice the fact that more attention was still required as to the exact meaning of the fatigue limit, and what its relation was to other properties of the metal. One of the most important points in the paper was certainly the criticism of a short life test. They must all regret that, but their regret must be tempered by the fact that, after all, it did not really matter very much if the fatigue limit could not be determined very quickly. The proper place to conduct endurance tests was in a laboratory. The ratio between the fatigue limit and the ultimate tensile strength, which Mr. Lessells had called k, was a ratio which had been shown to vary, but only between narrow limits. Ten years ago, Professor Haigh said, he had shown that the fatigue limit might rise as high in some metals as 60 per cent. of the ultimate tensile strength. He had shown also that it very rarely dropped below 40 per cent. in any metal that an engineer would be likely to use where there was any chance of vibration. It was quite true that it might go down to 0·15 in abnormal metals, but those metals were not such as any of them would attempt to use where there was vibration. Recently he had had a turbine shaft sent to him that had been fractured. They had measured the ultimate tensile strength and the fatigue limit, and they got a ratio of 35 per cent. and, without hesitation, he had reported that that was a contributory cause of failure. A designer would not be far wrong if he took the ratio as round about 45 per cent.

Professor Lea, in reply to the discussion on his paper, suggested that Dr. Thomson had been reading into his paper things that he had never intended. He had not presumed, as an engineer, to express any very definite opinions on the question of the mobile film. Referring to his use of the term "viscous," he said that it was a fact that the material did continue to elongate under constant load. As far as Dickenson's work was concerned, he was sorry that he had made no reference to it. Kelvin had done a good deal of work on cast iron under certain stresses. Dickenson had done first-class work at certain temperatures, but he did not think that Dickenson had really attempted to show that there was a stress at a particular temperature at which the creep would cease. He (the speaker) suggested that there was. Mr. Bailey had also referred to Mr. Dickenson's work. He thought that his suggestion that the hypothesis might not be applicable above a certain temperature was a very valuable contribution to the discussion which they would need further to explore.

THE OXYLENE TIMBER FIRE-PROOFING PROCESS.

THE innumerable uses to which timber has been put include many cases in which the combustible properties of the material constitute a danger to public safety. To diminish these risks various regulations have been enacted from time to time, as for instance those included in the Building Acts of the London County Council, under which only hardwoods, such as oak and teak, were until recently scheduled amongst fire-resisting materials and, consequently, these had to be used in certain types of constructional work. Such measures, however, provided only slightly greater safeguards at greatly increased cost to that which would have obtained if the more usual soft woods like deal and pitch pine could have been utilised, and the classification has now been extended to include soft woods which have been previously submitted to approved treatment. Considerations bearing on the inflammable nature of ordinary timber are also of importance in connection with ship construction. In the light of these points it is not surprising that methods of rendering wood fireproof have been sought for many years. It has only been comparatively recently however, that the process has been attempted on a commercial scale, and it is necessary to acknowledge in this connection that the earlier methods employed have not altogether been successful. The problems are numerous. It is essential that however treated, the material must remain in good conditon, free from mechanical disruption, dry rot, &c., and be without deleterious effect on metal fastenings in contact with it. Also, it must have no damaging effect on machinery and tools with which it is worked. The ordinary processes of surfacing, painting and polishing must likewise be possible. It was failure to satisfy one or other of these conditions which resulted in the abandonment of various early processes carried out both in Britain and the United States. In that of the Timber Fireproofing Co., Limited, of Market Bosworth, near Nuneaton, it is claimed that all objections in the treated wood have been entirely overcome. The value of the system is made sufficiently evident from the fact that after submitting various examples of the treated material to tests over a period of five years, the British Admiralty gave a satisfactory report on the process. A description of the process, together with some details of the disposition and nature of the plant employed at the Market Bosworth Works of the Company will thus be of interest to engineers.

The method adopted is to submit wood first to a thorough steaming under high pressure in steel cylinders, the duration and intensity of the treatment depending on the hardness, dimensions, quality and nature of the specimen. By this means the pores of the wood are opened and the sap water present there vaporised. Secondly, a vacuum is imposed on the cylinders secured by cutting off the supply of steam and connecting up to them a vacuum pump and a condenser. By these means the air in the wood and the vaporised sap are withdrawn into the condenser and, while still under vacuum, an aqueous solution of phosphate of ammonia and other anti-pyrene chemicals is run into the steel containers from tanks situated over them. When filled, the main supply to the cylinders is shut off, and the wood impregnated under hydraulic pressure. After a definite interval the pressure is cut off and the solution allowed to drain into a trough below the cylinder. The timber is then removed and stacked in kilns. Each plank is separated from its neighbour by light lathes. A constant draught of warm dry air is allowed to play on the wood and so crystallise the solution in the fibres of the wood, completing the treatment.

The theory of the action which ensues when heat is applied to the treated timber is very simple. Heat causes the expansion of the crystals on the outside of the wood. These form a glassy coating on the surface which excludes the oxygen contained in the atmosphere from, and prevents it combining with, the cellulose material forming the wood. The more intense the heat the greater is the expansion of the

THE OXYLENE TIMBER FIREPROOFING PROCESS.

Fig. 1. CROSS SECTION ON LINE A.A.

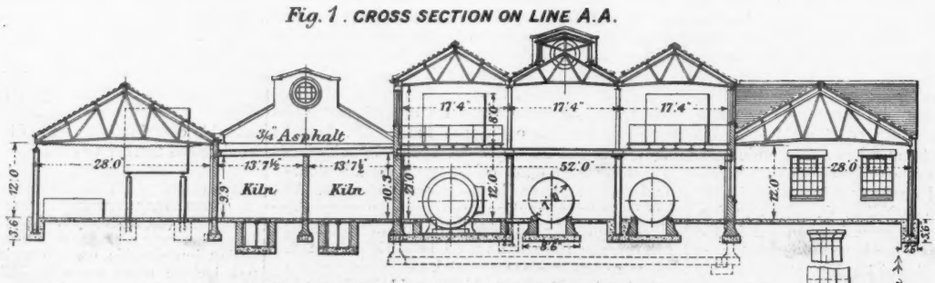


Fig. 2. LONGITUDINAL SECTION ON LINE B.B.

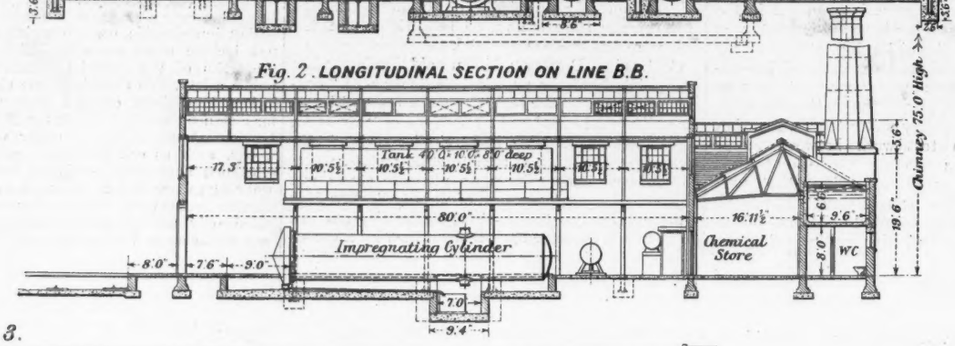
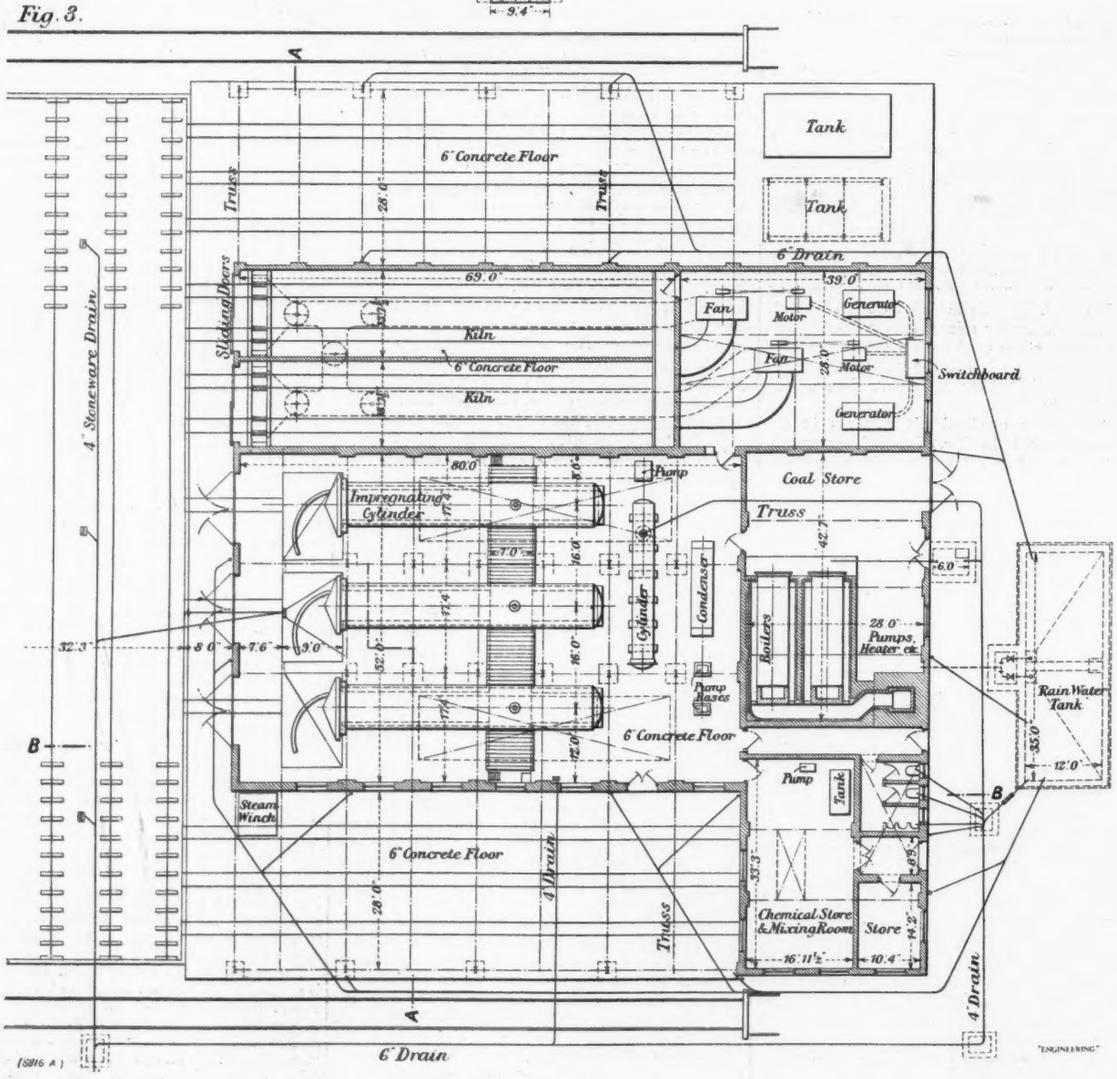


Fig. 3.



THE OXYLENE TIMBER FIREPROOFING PROCESS.

FIG. 4. GENERAL VIEW OF THE WORKS.

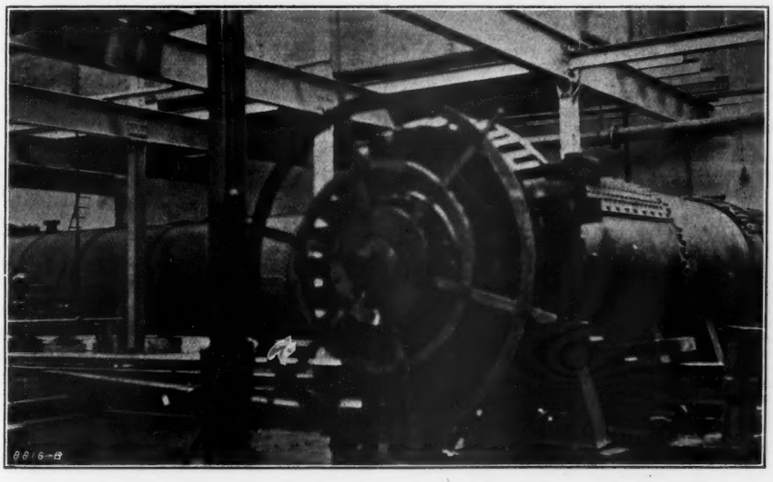


FIG. 5. IMPREGNATING CYLINDERS.

crystals, and when those contiguous to the source of heat in time become exhausted and the wood charred, fresh crystals come into action and sustain the fire-resisting effect.

The arrangement of the Market Bosworth Works of the company is shown in Figs. 1 to 3 opposite. They are compactly grouped together. The whole area, both shops and yards, has concrete flooring. At one side of the building, shown on the top of the plan, a shed for untreated timber has been built. It is roofed over but otherwise open to the weather. A track having a gauge of 2 ft. 0 in. serves this store, the material being handled on trucks constructed of angle irons. The trucks are loaded up at this store, and are of such dimensions that they can be run into the cylinders with their load. A circular vertical hoop fixed to each truck end serves as a gauge for loading. Each of the trucks can accommodate up to 54 4 in. by 8 in. by 12 ft. planks. Adjoining the loading shed are two kiln rooms for drying the timber after treatment; these we shall refer to again later.

Passing on to the next department, the main treating room, the plan shows the location of the impregnating cylinders and auxiliary apparatus. Three of the steel cylinders are 40 ft. long and 7 ft. in diameter, the metal being ¾ in. thick. A fourth cylinder, 25 ft. in length and 3 ft. 6 in. in diameter, is used for smaller work. The large cylinders contain guides near the bottom on which the loaded cars are run in and which engage with the trucks to prevent them floating when treatment is in progress. A good idea of the general appearance of the cylinders may be obtained from Fig. 5, above, which shows the small one in the foreground and one of the large ones mentioned above running in a direction at right angles to it. The high pressures to which the cylinders are subjected necessitates a very secure door fastening equipment, and this is arranged by using a number of strong steel bars attached to a collar engaging with a central screw on the outside of the doors. The turning of this screw, performed by means of the large hand wheel arms shown, causes the bars to slide into or return from steel loops mounted on front of the cylinder. Above each cylinder is mounted a wrought-iron tank carried on a platform supported by steel stanchions. These tanks contain supplies of the impregnating fluid. Set into the concrete floor are three further tanks, a drainage pump for reclaiming unused solution and restoring it to the overhead tanks being connected to each of them. An air or vacuum pump operated through 6-in. piping can be connected to any one of the cylinders, while the hydraulic pump operates through 3-in. piping. In this section of the building a tubular condenser 15 ft. long by 2 ft. 6 in. in diameter is housed; this works in conjunction with the exhausting pump. The latter acts on the cylinders, withdrawing air and steam at the end of the original steaming of the timber and, following impregnation, the pump is reversed, with the result that the surplus impregnation solution is forced back to the top tanks.

The treating room is adjoined by a yard, seen in Figs. 1 and 3. This yard contains a water softener, a steam winch and a large supply of load trucks. A traverser, having hand gear in case of failure of the power supply, runs along a track shown to the left of Fig. 3 and is fitted with rails just on a level with the general concrete floor. The arrangement is also illustrated in the view of the plant given in Fig. 4. Loaded trucks from the shed first described are run on to this traverser, which is of substantial construction. A steel rope running from the steam winch in the yard passes round guide pulleys fitted to the floor and moves the traverser to any desired position, permitting the trucks to be run on to the tracks leading to the treating cylinders or drying kilns. The two kilns each possess two lines of track under which ducts have been laid in the concrete floor. These ducts are covered with expanded metal and connect with the power house situated immediately behind the kilns, from whence a current of warm air is maintained, provided by a Buffalo and a Sirocco fan, the latter complete with heating and cooling batteries. The position of the dampers regulating the air supply is shown in Fig. 1. The air is driven past the wood stacked with lathes to ensure good ventilation, back again over a condenser coil to become reheated.

The boiler house, situated behind the treating room, contains two Cornish type steam boilers, each 18 ft. long and having 2 ft. 9 in. flues. They work at a pressure of 120 lb. per square inch. Two boiler-feed pumps, one with a heater, are included in the equipment of this department. Situated behind the kilns, the power house already referred to contains two 18-kw. electrical generating sets running at 300 r.p.m. and delivering a current of 170 amperes at a pressure of 105 volts. Two 20 brake horse-power motors are included which drive the fans. A ¾-h.p. booster motor, a switchboard, and a 60-volt battery of cells complete the equipment. Situated at the back of the yard is the chemical mixing room, containing a tank for mixing solution, fitted with a steam boiling coil, and provided with a pump. Samples of treated wood are tested here. A main of 2½ in. diameter connects the mixing tank with those over the cylinders.

A point of interest is the water supply, which normally is not first class in quality or quantity. In Figs. 2 and 3 the location is shown of a general ground storage tank of 20,000 gallons capacity, and a concrete tank of 6,000 gallons capacity, situated in the higher part of the building. Lines are drawn in the diagram indicating the run of the rain water collector drains. The steam pump in the mixing room supplies water from the underground storage tank to the mixing tank. Facilities exist at these works for treating approximately 250,000 cub. ft. of timber per annum.

5/13½-TON FIXED ELECTRIC TOWER CRANE.

FOR shipyard purposes the cranes that are installed must be of great height and be capable of carrying their loads out a considerable distance, because of the dimensions of the vessels that have to be fitted out. A good example is afforded by the illustration on page 16, which depicts what is believed to be the largest crane of its type in the country, so far as radius and height are concerned. It was built for Messrs. R. and W. Hawthorn, Leslie and Co., Limited, and erected at their Hebburn shipyard by Sir William

Arrol and Co., Limited, of Parkhead, Glasgow. A very good impression of the size of the crane is given by the illustration, in which ships are shown alongside the quay, but the actual dimensions must be stated if a true estimate is to be made of its size in comparison with other cranes of the type. It has a height of lift above the ground level of 150 ft., and has, in addition, a range below the ground level of 20 ft. A 5-ton load may be handled by it at a radius of 162 ft., while it is also capable of dealing with larger loads at smaller radii as follow:— 7½ tons at 110½ ft. and 13½ tons at 60½ ft. radius.

The tower of the crane is built up of rolled steel sections and plates which are well braced and riveted together. On top of the tower a steel roller path is fitted to give lateral support to the mast. At the foot the bracing of the tower is arranged in the form of a portal, for the purpose of providing a clear opening through it, immediately above which there are strong cross girders to carry the pivot bearings for the foot of the mast. Both mast and cantilever are made up from mild steel sections. From the illustration it will be seen that the cantilever is of the open-trussed type. For the construction of the lower boom, rolled steel channels and angles are used, and they are strongly braced in order that the stresses due to slewing and wind may be effectively resisted. The weight of the revolving part of the crane is carried by a footstep bearing of a suitable design to keep down the frictional resistance to a minimum. Horizontal support is afforded to the mast by the use of cast-steel rollers of large diameters, attached to the mast and set with their axes vertical. These run inside the steel roller path carried at the top of the tower. The outside of this roller path is provided with pins which form a rack, which is in gear with a pinion carried on the lower end of a vertical shaft supported in massive bearings on the mast and driven by a motor of 20 brake horse-power through a worm gear and a spur reduction gear. This equipment for slewing, which gives a speed of ¼ r.p.m. when the load is 13½ tons, has a special design of friction clutch, so adjusted that when the gear is subjected to heavy shocks it slips sufficiently to absorb the shock and prevent damage to the gearing. A foot brake is also provided to control the slewing motion.

For hoisting purposes, a trolley is mounted between the two rolled-steel channels forming the bottom boom of the cantilever. This trolley is made with a mild-steel plate frame, and is supported on four cast-steel wheels, the bearings of the shafts of which are provided with gun-metal bushes. The load is lifted on four wire ropes, made from the best plough steel, two of which are wound on a cast-iron drum driven by an electric motor of 50 brake horse-power through machine-cut steel gears of the spur type. Actually two sets of gearing are provided, as the crane must hoist at a speed of 100 ft. per minute with a load of 5 tons, and at 35 ft. per minute if the load is 13½ tons. Changing from one speed to the other is effected by the use of a lever operating a claw clutch. The hoisting drum is turned and grooved, both right and left handed, to take the full amount of rope in a single lap. This wire rope is sufficiently long to leave three coils on each end of the barrel when the hook is in its lowest position. To hold the load after lifting, an automatic electric brake is fitted to the motor spindle and is operated by a solenoid magnet connected in such a manner that the brake is released the moment the motor is started and is applied whenever the current is cut off or fails from any cause. This brake is of the post type, and has straps of forged steel and blocks of cast iron lined with Ferodo. A hand release gear is available and is operated from the driver's cabin. To ensure that no excessive speed is attained by the descending load, a centrifugal brake is also installed, which can be adjusted to come into action at any predetermined speed. The snatch block has two cast-iron sleeves, which are bushed with gun-metal and mounted on the ends of a steel crosshead, from which the hook is suspended, with the intervention of a ball bearing. Effective guards around the sheaves prevent the ropes getting out of place.

The trolley is traversed along the cantilever, at a speed of 75 ft. per minute, when a load of 13½ tons is carried, by means of two ropes attached to each end and winding on a cast-iron drum, rotated by a 10 brake horse-power motor through double-reduction spur gearing. For this part of the equipment, an automatic solenoid brake is fitted to the motor spindle. The driver's cabin is attached to the underside of the cantilever and has a steel frame. From it a full view of the operations is obtained under all conditions through large windows on three sides. Within this cabin all the controllers, resistances and the switchboard are erected. The controllers installed are of the drum-reversing type, with metallic resistances of the Electro-Mechanical Brake Company's manufacture. Totally-enclosed, self-resetting limit switches are used to prevent overwinding of the hook and over-racking of the trolley in either direction. Above the centre pivot there is a slip-ring collector, having three rings for the main circuit.

Under the prescribed tests, the crane proved in every way satisfactory, and, indeed, the demands were exceeded in almost every operation such as hoisting, racking in and out and slewing. No permanent deflection was found at the point of the cantilever on the removal of the loads after the tests.

BOOKS RECEIVED.

The Theory of Relativity. By L. SILBERSTEIN, Ph.D. Second edition. London: Macmillan and Co., Limited. Price 25*s.* net.

Conférences Scientifiques. By ALBERT TURPAIN. No. 1. *Le nouveau Domaine de l'Electricité: L'evolution des théories Electriques.* No. 2. *L'Eclairage et le chauffage Electrique: La naissance d'une Lampe à Incandescence.* No. 3. *L'Air Liquide: Le Froid Industriel et son Utilisation.* No. 4. *De la Presse à bras à la Linotype et à l'Electrotypographe. Les Presses à Imprimer. Les Machines à Composer.* No. 5. *Le Cinématographe. Le film Coloré. Le film Parlant.* Paris: Gauthier Villars et Cie. [Price 5 francs each.]

United States Bureau of Labour Statistics. Bulletin No. 361. *Labour Relations in the Fairmont, West Virginia, Bituminous Coal Field.* By BORIS EMMET. Washington: Government Printing Office. [Price 10 cents.]

Elektrische Maschinen. Vol. I. *Allgemeine Berechnungselemente. Die Gleichstrommaschinen.* By RUDOLF RICHTER. Berlin: Julius Springer. [Price 27 gold marks.]

Engineering Mathematics, Part II. By R. W. M. GIBBS, B.A., B.Sc. London: Blackie and Son, Limited. [Price 1*s.* 3*d.* net.]

A Book about Engineering Wonders. By ERNEST PROTHEROE. London: The Epworth Press. [Price 2*s.* net.]

United States Bureau of Standards. Circular No. 100. *Nickel and Its Alloys.* Second edition. [Price 40 cents.] No. 101. *Physical Properties of Materials. I. Strength and Related Properties of Metals and Wood.* Second edition. [Price 40 cents.] No. 154. *National Standard Petroleum Oil Tables.* [Price 30 cents.] Washington: Government Printing Office.

The Military Uses of Astronomy. By MAJOR F. C. MOLESWORTH, R.E., F.R.A.S. London: Longmans, Green and Co. [Price 3*s.* 6*d.* net.]

Sulphuric Acid Concentration. Vol. II. *In Heated Vessels.* By P. PARRISH, A.I.C., and F. C. SNELLING. London: Ernest Benn, Limited. [Price 6*s.* net.]

Rats and How to Destroy Them. By MARK HOWELL, F.R.C.S. London: John Bale, Sons and Danielsson, Limited. [Price 10*s.* 6*d.* net.]

Mechanics of Textile Machinery. By WILLIAM A. HANTON, M.Sc. London: Longmans, Green and Co. [Price 12*s.* 6*d.* net.]

Draht-Welt-Buch. Lehr- und Nachschlagebuch fur die gesamte Draht-Industrie. By MARTIN BOERNER. Halle a/s: Martin Boerner.

University of Illinois. Engineering Experiment Station. Bulletin No. 143. *Tests on the Hydraulics and Pneumatics of House Plumbing.* By HAROLD E. BABBITT. Urbana: University of Illinois. [Price 45 cents.]

United States Bureau of Standards. Technological Papers No. 257. *Development of a Method for Measurement of Internal Stress in Brass Tubing.* By R. J. ANDERSON and E. G. FAHLMAN. [Price 5 cents.]. No. 258. *Strength of Steel Tubing under Combined Column and Transverse Loading, including Tests of Columns and Beams.* By T. W. GREENE. [Price 15 cents.] No. 273. *Performance Tests of a Liquid Laundry Soap Used with Textile Materials.* By F. R. MCGOWAN and OTHERS. [Price 10 cents. Washington: Government Printing Office.

Einführung in die Elektrotechnik Hochschulvorlesungen. By Dr. C. HEINKE. Second edition. Berlin and Leipzig: Walter de Gruyter and Co. [Price 18 marks.]

Economics of Iron and Steel. By H. J. SKELTON. Second edition. London: Stevens and Sons, Limited. [Price 1*l.* net.]

Workshop Gauges and Measuring Appliances. An Introductory Treatise. By LOUIS BURN. London: Sir Isaac Pitman and Sons, Limited. [Price 5*s.* net.]

Relativity and Common Sense. By F. M. DENTON, A.C.G.I., M.I.E.E. Cambridge: University Press. [Price 10*s.* net.]

Die Kreiselpumpen. By C. PFLEIDERER. Berlin: Julius Springer. [Price 22·50 dols.]

Entropie das Wasserdampfes in elementarer Ableitung. By FRITZ BÖRK. Leipzig: Otto Spamer. [Price 2 gold marks.]

Physics in Industry. Lectures delivered before the Institute of Physics. Vol. II. London: Humphrey Milford. [Price 3*s.* net.]

JUNIOR INSTITUTION OF ENGINEERS.—On Friday, December 19, Colonel the Master of Sempill delivered a lecture on "Aircraft in Japan" before the Junior Institution of Engineers at 39, Victoria-street, London, S.W. 1. In the course of his address Colonel Sempill stated that the Japanese air forces had been raised and developed entirely under the supervision of a British Mission during the last three years. He declared the Japanese made very good pilots and gave an interesting description of the construction of an air station, which he illustrated by means of lantern slides.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Iron and Steel.—Though current production is restricted owing to the operation of holiday influences, the new year outlook is viewed in most quarters with quiet optimism. Nothing in the nature of a boom is expected or desired, but there are fairly reliable indications that conditions during the next 12 months will show a marked improvement, always provided that large-scale labour troubles are avoided. The Lord Mayor of Sheffield, Alderman A. J. Bailey, a trade union official with something like a quarter of a century's experience of the local steel and allied industries, says that during the past six months an improvement has been plainly shown, and he is of the opinion that current prospects are brighter than during any period within the past four years. Leading employers concur, pointing out that increased confidence among business people throughout the country is finding tangible expression in inquiries and orders. In the main, prices are exceptionally favourable to buyers, embodying as they do a margin of profit that in pre-war times would have been considered inadequate to recompense investors for the large amount of capital outlaid. The number of inquiries in circulation points to the advent of increased business in pig-iron and hematites, though production has been greatly restricted and requirements will need to show a substantial expansion before normal conditions are restored, and having regard to the fact that revival has not materialised when previously promised, both producers and consumers are adopting an attitude of caution. Sales of steel billets continue to be adversely affected by Continental competition. A strong case could be made out for the adoption of safeguarding powers, but, on the other hand, this would arouse widespread opposition from re-rollers of cheap imported material. Further large contracts about to be placed by British railway companies are expected to result in substantial orders being received in Sheffield and district for steelwork, axles, tyres and springs, which in turn will swell the demand for engineers' tools, files and twist drills. Better business is also anticipated with the Indian, South American and Colonial railways. According to present indications, ship steel is likely to improve. Increased business is also forecast in structural steel and builders' ironwork.

South Yorkshire Coal Trade.—The market has not got properly into its stride following the holiday stoppage, but signs are not wanting of an improved tone in some of the leading sections. Export trade in best steams continues disappointing, though the home demand is fairly robust. Cobbles, nuts and best quality slacks continue in moderate request, with bunkering coal a fairly active feature. House-coal merchants have a fair number of arrears to wipe off, though the volume of outstanding business falls considerably below the seasonal average. Coke of all descriptions is unchanged. Quotations:—Best branch hand-picked, 32*s.* to 35*s.*; Barnsley best Silkstone, 26*s.* to 28*s.*; Derbyshire best brights, 27*s.* to 32*s.*; Derbyshire best house, 24*s.* to 26*s.*; Derbyshire best large nuts, 22*s.* 6*d.* to 25*s.*; Derbyshire best small nuts, 14*s.* to 16*s.*; Yorkshire hards, 20*s.* to 23*s.* 6*d.*; Derbyshire hards, 19*s.* 6*d.* to 22*s.*; rough slacks, 9*s.* 6*d.* to 12*s.*; nutty slacks, 8*s.* 6*d.* to 10*s.* 6*d.*; smalls, 4*s.* to 6*s.* 6*d.*

A POLISH NAVY.—The Military Commission of the Polish Diet have recently proposed a coast-defence programme. The construction of three cruisers, six destroyers, 12 torpedo boats, 12 submarines, and 36 auxiliaries within twelve years is recommended. The Diet has not yet discussed the project.

"ELECTRICAL MACHINERY AND CONTROL DIAGRAMS."—In our issue of December 19, reviewing Mr. Terrell Croft's book with the above title, we suggested that it was difficult to believe that there could exist any large demand for a book of its class. The publishers, Messrs. McGraw-Hill Publishing Company, however, inform us that "there has been an extraordinarily big demand" for the volume. This fact clearly illustrates the ever-growing importance of electrical methods and a growing realisation of the value of a proper understanding of their plants on the part of engineers.

THE LEIPZIG SPRING FAIR.—Although the space hitherto at the disposal of the technical section of the Leipzig Fair has been extended from 80,000 sq. metres to 130,000 sq. metres, almost the whole of the available space has already been taken up by exhibitors. The lignite section, on view for the second time, and the heating department, a new addition to the Fair, will greatly exceed in size the space originally allotted to them. Considerable extensions to other departments are allowed for in three new halls and several large tents at present being erected.

PERSONAL.—The Flexible Shaft Manufacturing Company, of Church-street, Stratford, have appointed The Westminster Tool and Electric Company, Limited, of Westool Works, Putney Bridge-road, London, S.W.15, selling agents for their flexible shafts and accessories.—Messrs. H. B. Barnard and Sons, metal merchants, refiners, and smelters, of Glyn-street, Vauxhall, London, S.E.11, have admitted Mr. Harry B. Barnard as a partner in the firm.—The Northwest Engineering Company, makers of convertible cranes, shovels and drag-line excavators operated by petrol engines, state that their sales office is being removed to the Steger Building, 28E Jackson Boulevard, Chicago, Ill., U.S.A.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scottish Steel Trade.—Work in the Scottish steel industry is now finished for the year, a year which has not been one of much joy to the various managements. The past week, like many of its predecessors, has not been very fruitful in the way of fresh business, and a poor demand has been general. Both plates and sections have been quiet, and, while there are hopes of an improvement after the holidays are over, there is really very little to build upon, and the outlook is not very bright. The works will, in most cases, be closed down for a week or ten days, but a full fortnight will be the length of the vacation in some establishments on account of the poor state of order books. While the holidays are on, advantage will be taken of the opportunity to overhaul and repair plant and effect any renewals found necessary. During the closing days of the year there has been an absence of any pressure for deliveries before the holidays, which is most unusual, and which would also tend to emphasise the real quietness of the steel trade. The black sheet makers, on the other hand, have been kept working well up to the very end on light and galvanised sheets, and have plenty of work to commence with after resumption. The demand for the heavier gauges has been poor, however, but there are prospects of some improvement in the near future. The general inquiry is quiet at the moment. Prices have not changed, and the following may be taken as the home quotations at the end of the year:—Boiler plates, 13*l.* per ton; ship plates, 9*l.* 15*s.* per ton; sections, 9*l.* 10*s.* per ton; and sheets, $\frac{3}{16}$ to $\frac{1}{4}$ in., 12*l.* per ton, all delivered Glasgow stations.

Malleable Iron Trade.—No improvement of any kind falls to be reported in the West of Scotland malleable-iron trade, and the closing down for the holidays affords a welcome, though temporary, relief from anxiety. The prospects for the early part of the new year are not bright, as order-books generally are far from full, but the new railway schemes lately reported will certainly mean an influx of business to this district, and the bar-iron makers will get a share of the work. The steel re-rolling branches have closed the year very quietly. The current price of "Crown" bars is 12*l.* per ton, delivered Glasgow stations.

Scottish Pig-Iron Trade.—The tone in the Scottish pig-iron trade is still dull, and bookings during the past week have not been very heavy. Local consumers have not been taking deliveries of any consequence of late, and the export trade has not yet shown any signs of a revival. Inquiries can only be called fair. The stocks on hand at the end of the year are quite equal to any normal demand which may take place at the end of the holidays, and the re-lighting of the furnaces is likely to be delayed a little longer than usual. Prices are unchanged and are as follow:—Scottish hematite, 4*l.* 15*s.* per ton, delivered at the steel works: foundry iron, No. 1, 4*l.* 15*s.* per ton, and No. 3, 4*l.* 10*s.* per ton, both on trucks at makers' yards.

Shipment of Scottish Pig-Iron.—The shipments of Scottish pig-iron from Glasgow Harbour for the week ending last Saturday, December 27, amounted to 1,213 tons overall. Of that total 1,150 tons went overseas and 63 tons coastwise. During the corresponding week of last year the figures were 775 tons foreign and 34 tons coastwise, making a total shipment of 809 tons.

SWANSEA METAL EXCHANGE REPORT.—The tinplate market at the Swansea Metal Exchange is at present very quiet. The decision to continue the scheme for the stabilisation of prices for another year, however, has had an immediate beneficial effect on business.

IRON AND STEEL IMPORTS FROM BELGIUM.—During the first half of the year 1924 imports into Great Britain from Belgium included 33,500 tons of pig iron; 222,000 tons of ingots, blooms, billets and sheet bars; 32,200 tons of structural steel; 22,700 tons of plates and sheets; and 11,200 tons of rails.

SECOND HAVANA INTERNATIONAL FAIR.—Attention is drawn to the desirability of strong British participation in the Second International Sample Fair of Havana, which is to be held in May next. The last Fair was a success, particularly from the standpoint of advertising. Foreign manufacturers exhibited in considerable strength. The purchasing capacity of Cuba has increased in comparison with pre-war years, goods to the value of over 226 million dollars being imported during the period 1922–23. It is suggested that firms desirous of entering the Cuban market would find the Fair an excellent starting point.

LONDON IRON AND STEEL EXCHANGE.—The weekly report of the London Iron and Steel Exchange Limited, dated December 23, 1924, states that a number of contracts with Belgian works have been cancelled by British buyers on account of current rumours of labour trouble in continental factories. Twelve works in Belgium, it is said, were to be closed at the end of the year, because of a lockout. A slight weakness in prices has developed in the pig iron department in the absence of business, but most producers are fairly well sold for the first few weeks of the New Year and are not inclined to make concessions. The situation as regards semi-finished materials is uncertain, while the demand for finished steel products is unchanged. The market at the close of the year, however, was in a much more healthy condition than it had been for some months past.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

Cleveland Iron Trade.—What is always the quietest week of the year has closed. As is usual between Christmas and New Year business has been practically suspended. With the holidays over traders are looking with confidence to steady expansion of business. The feeling prevails that quotations are likely to show little movement for some time, and with this opinion freely expressed forward contracts promise to be arranged. Improvement in home demand for Cleveland pig is fully expected, and indication is not lacking of likely increase in overseas trade. No. 1 Cleveland is 86*s.* to 86*s.* 6*d.*; No. 3 g.m.b., 81*s.* to 81*s.* 6*d.*; No. 4 foundry, 80*s.* 6*d.*; and No. 4 forge, 80*s.*

Hematite.—The statistical state of the East Coast hematite iron trade is unsatisfactory, makers having heavy stocks, but hope is entertained that requirements of the near future will be such as will absorb the increased output that will come upon the market by the re-kindling of two idle furnaces about the middle of January. Nos. 1, 2 and 3 are on sale at 87*s.* 6*d.* to 88*s.*, and No. 1 is put at 6*d.* above mixed Nos.

Foreign Ore.—There is little or nothing doing in imported ore. Sellers still base market quotations on best rubio at 22*s.* 6*d.* c.i.f. Tees, but would doubtless entertain offers on lower terms.

Blastfurnace Coke.—Durham blastfurnace coke keeps steady at 25*s.* for good medium qualities delivered to consumers in this district, and several contracts are stated to have been made at round about that figure for supply over periods to the end of June.

Manufactured Iron and Steel.—Several works are still closed for the holidays. Manufacturers of some descriptions of finished iron and steel have fairly good contracts made, but in nearly all branches more orders would be very welcome. Prices are maintained, common iron bars being 12*l.*; iron rivets, 14*l.*; packing (parallel), 8*l.* 10*s.*; packing (tapered), 11*l.* 10*s.*; steel billets (soft), 8*l.* 10*s.*; steel billets (medium), 9*l.*; steel billets (hard), 9*l.* 10*s.*; steel boiler plates, 13*l.*; steel ship, bridge and tank plates, 9*l.* 15*s.*; steel angles, 9*l.* 10*s.*; steel joists, 9*l.* 10*s.*; heavy steel rails, 9*l.*; fish plates, 12*l.* 10*s.*; and galvanised corrugated sheets (24 in. gauge, in bundles), 17*l.* 10*s.* to 17*l.* 15*s.*

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Coal Trade.—Holiday influences were still in evidence this week and little business was transacted. Operators generally were content to follow a waiting policy, and in this attitude were influenced by the fact that the gales have delayed the arrival of shipping. The result was that whereas prior to the holidays vessels were waiting for loading berths the position was reversed and to-day there were over 20 tips idle. Normal working, however, had not been restored at the collieries, and as stocks of coal were reduced during the holidays colliery salesmen refused to modify their quotations except for immediate shipment, hoping that the weather would moderate and that tonnage would come up with a rush. Most undertakings were fairly well stemmed on paper, and should shipping reach port more freely there is no doubt that supplies of coal would be more difficult to secure. The general tendency of the market, however, was certainly weaker, and with the inquiry limited, buyers wherever practicable were holding off confidently expecting to see lower prices, or, at any rate, irregularity when things settle down. The Roumanian State Railways were inviting tenders for 100,000 tons of best Admiralty large coal to be delivered c.i.f. over next year, and it was reported that best bunker smalls had been sold over next year at 16*s.* 3*d.* f.o.b. Shipments of coal as cargo from South Wales last week amounted to only 249,970 tons, against 627,560 tons in the previous week, the reduction being due to the intervention of the Christmas holidays and the cessation of work at the docks from Wednesday night to Monday morning. Best Admiralty large coals ruled round 27*s.* 6*d.*, with seconds from 25*s.* to 26*s.* 6*d.*, and Monmouthshires from 23*s.* to 25*s.* Best steam smalls were round 16*s.*, with good bunker sorts available at 14*s.* 6*d.* and inferiors from 12*s.*

Iron and Steel.—Exports of iron and steel goods from South Wales in the past week totalled 12,872 tons, compared with 4,312 tons in the previous week. Shipments of tinplates and terneplates totalled 4,044 tons, against 2,840 tons; black plates and sheets, 1,948 tons, against 439 tons; galvanised sheets, 4,655 tons, against 308 tons; and other iron and steel goods, 2,215 tons, against 825 tons. At the moment the tinplate trade is active, with a good inquiry from the Far East, in view of an anticipated advance in tin and freight rates. Prices are steady at the minimum schedule of 23*s.* 6*d.*

CONTRACT.—Messrs. Sterns, Limited, of Royal London House, Finsbury Square, London, E.C., have secured a large contract from the Air Ministry for the supply of oils for aircraft engines.—The General Electric Company, Limited, of Magnet House, Kingsway, London, W.C.2, have secured contracts from the India Office for the supply of Edison primary cells and renewals, track circuit and polarised relays and signal lever contact makers; and from the Great Western Railway Company and the London and North Eastern Railway Company for a year's supply of track relays and resistance units.

NOTICES OF MEETINGS.

THE JUNIOR INSTITUTION OF ENGINEERS.—To-night, at 7.30 p.m., at 39, Victoria-street, S.W. 1. Extraordinary General Meeting and Lecturette: "Modern Flour-Milling Machinery," by Mr. W. Ringrose. Wednesday, January 7, at 7.30 p.m., at the Royal Society of Arts, John-street, Adelphi, W.C. 2. Inaugural Meeting. Presidential Address by Dr. Alexander Russell.

THE INSTITUTE OF TRANSPORT.—Monday, January 5, at 5.30 p.m., at the Institution of Electrical Engineers, Victoria Embankment, W.C. 2. "Recent Developments in the Industrial Aspects of Transportation," by Brig.-Gen. H. O. Mance, C.B., C.M.G.

THE JUNIOR INSTITUTION OF ENGINEERS: NORTH WESTERN SECTION.—Monday, January 5, at 7.15 p.m., at the Manchester Geographical Society, 16, St. Mary's Parsonage, Manchester. Presidential address by Mr. A. P. M. Fleming, M.Sc., M.I.E.E., "The Outlook of Engineering."

THE BRADFORD ENGINEERING SOCIETY.—Monday, January 5, at 7.30 p.m., at the Bradford Technical College. Lecture: "Geared Steam-Turbine Drive for Textile Mills," by Mr. B. C. Johnson.

THE INSTITUTION OF CIVIL ENGINEERS: NEWCASTLE-UPON-TYNE ASSOCIATION.—Monday, January 5, at 7.30 p.m., in the Lecture Theatre of the Mining Institute, Neville Hall, Newcastle-upon-Tyne. "The Newcastle and Carlisle Railway—Ninety Years Ago and To-day," by Mr. F. E. Harrison, M.Inst.C.E.

THE INSTITUTION OF RUBBER INDUSTRY.—Monday, January 5, at 8 p.m., at the Engineers' Club, Coventry-street, W. 1. "Mechanical Structure of Rubber," by Mr. A. Healey, B.Sc.

THE INSTITUTION OF PETROLEUM TECHNOLOGISTS.—Tuesday, January 6, at 5.30 p.m., at the Royal Society of Arts, John-street, Adelphi, W.C. 2. "The Behaviour of Lubricating Oils under Oxidising Conditions," by Mr. John B. Hoblyn, A.R.C.Sc., F.I.C.

THE INSTITUTE OF MARINE ENGINEERS.—Tuesday, January 6, at 6.30 p.m., at 85–88, The Minories, Tower Hill, E. 1. "Some Considerations in Connection with the Measurement of Liquid Fuel Storage and Liquid Depths," by Mr. Chas. H. Wright.

THE INSTITUTE OF METALS: BIRMINGHAM LOCAL SECTION.—Tuesday, January 6, at 7 p.m., in the Chamber of Commerce, New-street. "Cobalt, its Production and Some of its Uses," by Mr. T. H. Gant, A.R.C.Sc.

THE WEST YORKSHIRE METALLURGICAL SOCIETY.—Tuesday, January 6, at 7.30 p.m., at the George Hotel, Huddersfield. Discussion on "The Value of Some Workshop and Laboratory Tests."

THE INSTITUTION OF ELECTRICAL ENGINEERS: WIRELESS SECTION MEETING.—Wednesday, January 7, at 6 p.m., at Victoria Embankment, W.C. 2. "A New Method of High-Frequency Resistance Measurement," by Prof. E. Mallett, M.Sc., and Mr. A. D. Blumlein.

THE INSTITUTION OF HEATING AND VENTILATING ENGINEERS.—Wednesday, January 7, at 7 p.m., at the Engineers' Club, Coventry-street, W. 1. "Water Gauge," by Mr. Oswald Stott.

THE LIVERPOOL ENGINEERING SOCIETY.—Wednesday, January 7, at 8 p.m., at the Society's Rooms, The Temple, Dale-street, Liverpool. "Manœuvring of Ships," by Miss E. M. Keary, A.M.I.N.A.

THE ROYAL AERONAUTICAL SOCIETY.—Thursday, January 8, at 5.30 p.m., at 7, Albemarle-street, W. 1. Discussion: "The Use of the Wind Channel to Aircraft Engineers," by Mr. C. C. Walker.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Thursday, January 8, at 6 p.m., at Victoria Embankment, W.C. 2. "Three-Wire Direct-Current Distribution Networks: Some Comparisons in Cost and Operation," by Mr. Herbert W. Taylor.

THE INSTITUTE OF MARINE ENGINEERS: LONDON LOCAL SECTION.—Thursday, January 8, at 7.30 p.m., at the Institute of Marine Engineers, 85–88, The Minories, Tower Hill, E. 1. "Extensometers," by Mr. K. H. Greaves, D.Sc., F.I.C.

THE INSTITUTION OF AERONAUTICAL ENGINEERS.—Friday, January 9, at 6.30 p.m., at the Engineers' Club, Coventry-street, W. 1. "The History and Evolution of the Avro Training Machine," by Mr. R. J. Parrott.

THE INSTITUTION OF MECHANICAL ENGINEERS.—Friday, January 9, at 7 p.m., at Storey's-gate, S.W. 1. Informal Meeting. "The Maintenance of High-Compression Oil Engines."

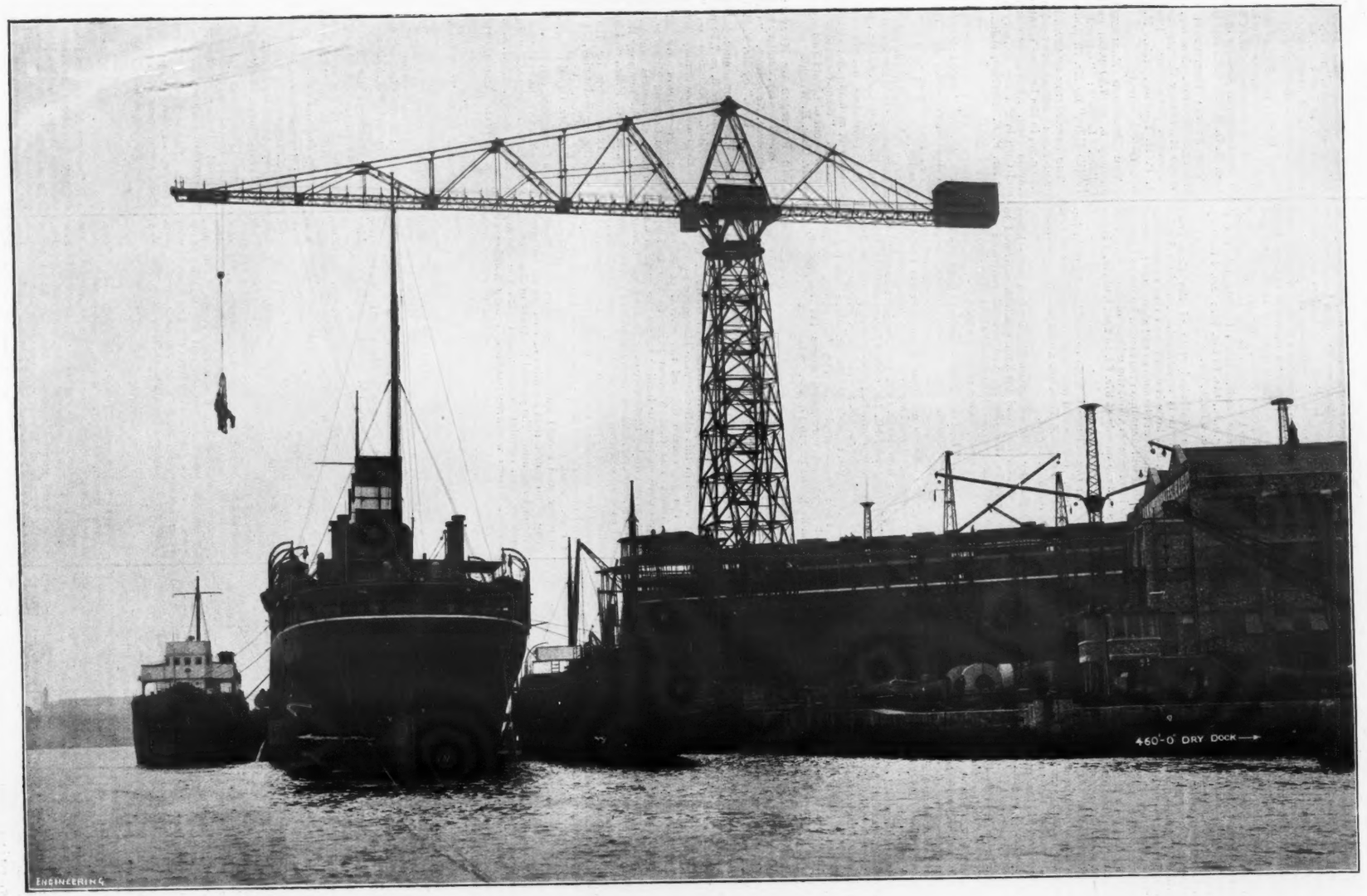
THE INSTITUTE OF METALS: SHEFFIELD LOCAL SECTION.—Friday, January 9, at 7.30 p.m., in the Mappin Hall, Department of Applied Science, The University, St. George's-square. "Die Casting," by Mr. A. H. Mundey.

SCIENTIFIC APPARATUS FOR THE UNITED STATES—An enquiry has been received at the Department of Overseas Trade, 35, Old Queen-street, London, S.W.1, from a firm in Boston, Mass., U.S.A., wishing to be placed in communication with United Kingom suppliers of apparatus required for lecture or laboratory work in teaching physics, chemistry, and biology in secondary schools and colleges. The department will be pleased to supply further particulars to British firms interested.

5/13½-TON TOWER CRANE AT THE HEBBURN SHIPYARD OF MESSRS. HAWTHORNE, LESLIE AND CO., LTD.

CONSTRUCTED BY SIR WILLIAM ARROL AND CO., LIMITED, ENGINEERS, GLASGOW.

(*For Description, see Page* 13.)



HYDRO-ELECTRIC PLANT AT FORSHUVUDFORSEN, SWEDEN.

(*For Description, see Page 6.*)

FIG. 1. VIEW OF POWER HOUSE AND DAM FROM DOWN-STREAM SIDE.

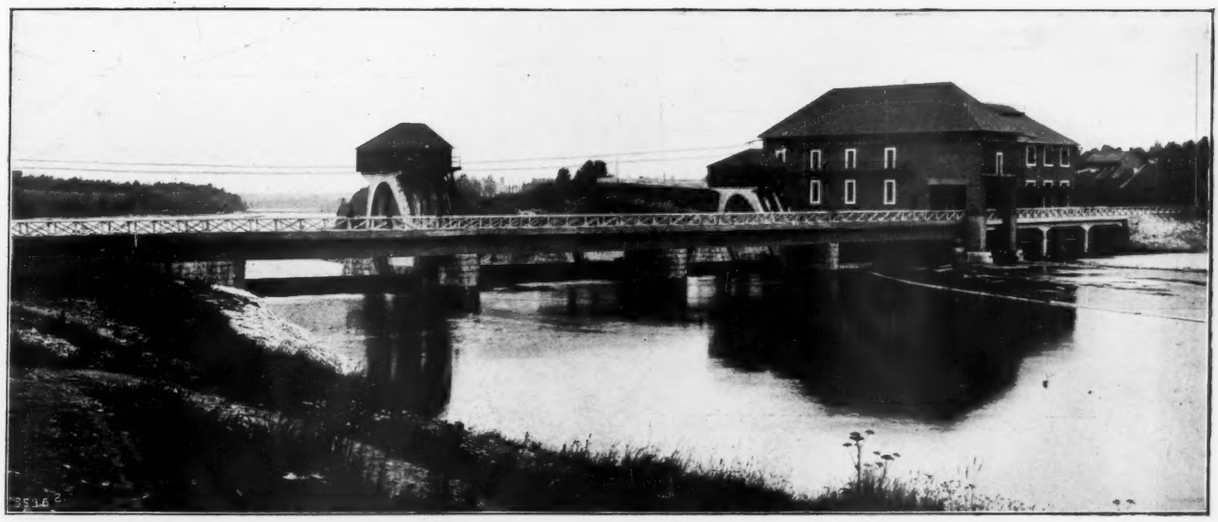
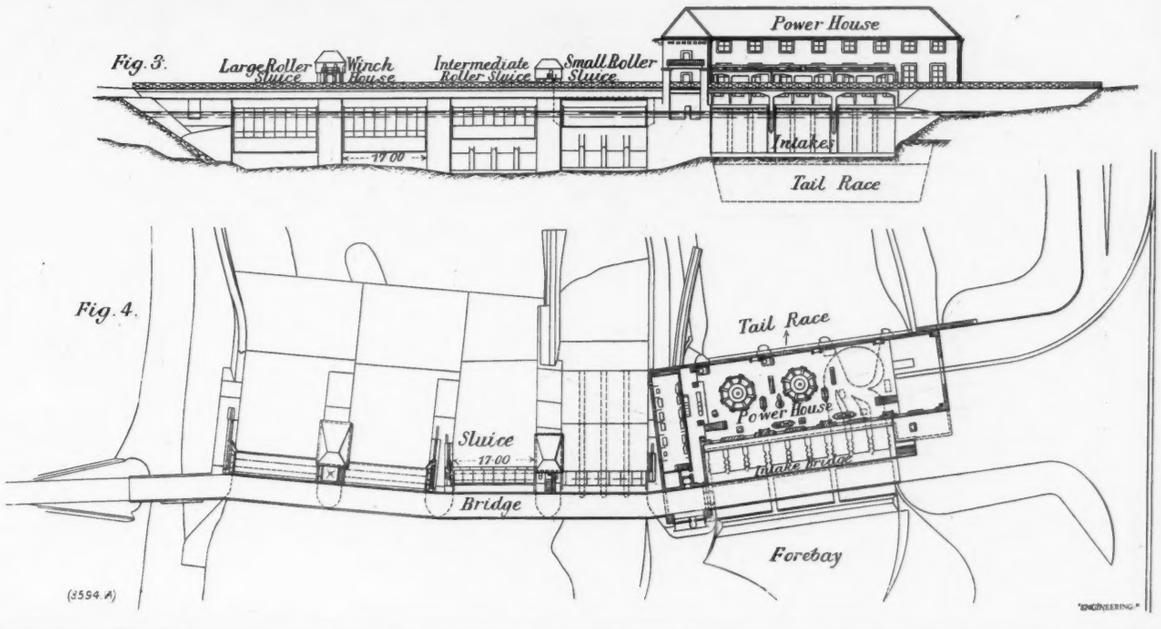


FIG. 2. VIEW OF POWER HOUSE AND DAM FROM UP-STREAM SIDE.



(*To face page 6.*)

DETAILS OF LARGE ROLLERS AT THE FORSHUVUDFORSEN DAM, SWEDEN.

(For Description, see Page 6.)

Fig. 5. CROSS SECTION THROUGH LARGEST DAM ROLLER.

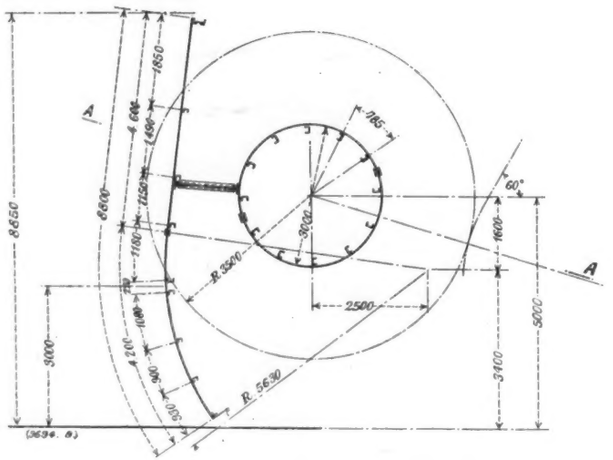


Fig. 6. LONGITUDINAL SECTION AND ELEVATION OF LARGEST DAM ROLLER.

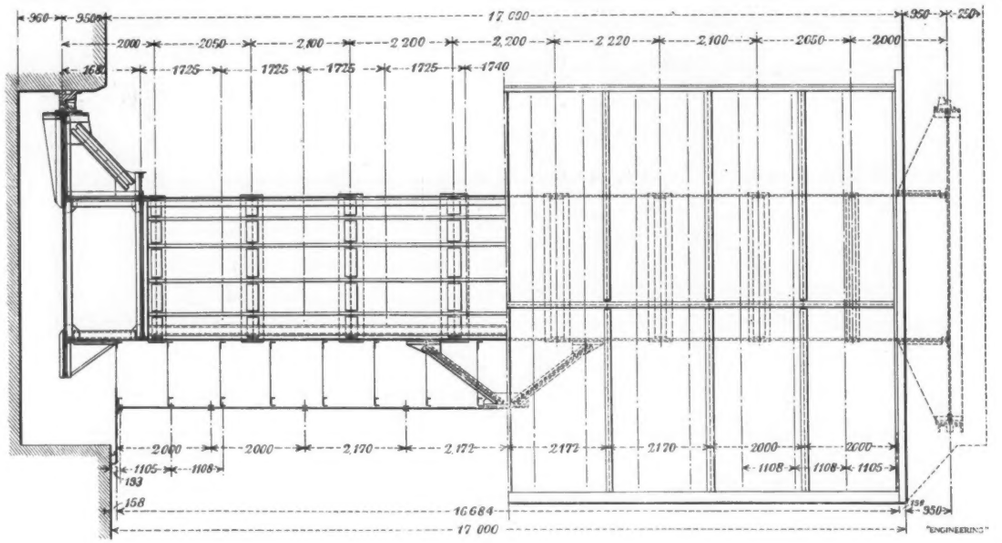


Fig. 7.

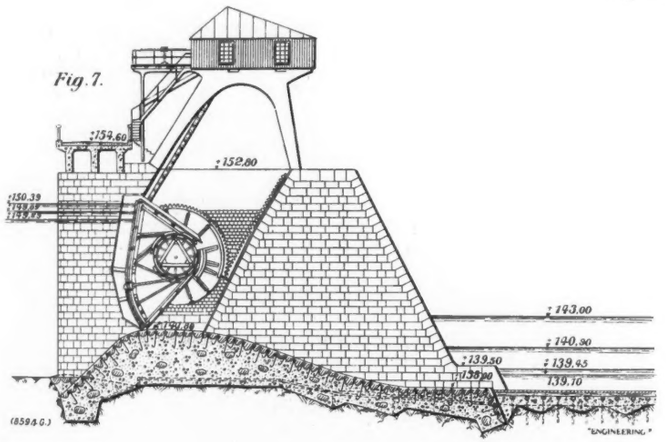


Fig. 8.

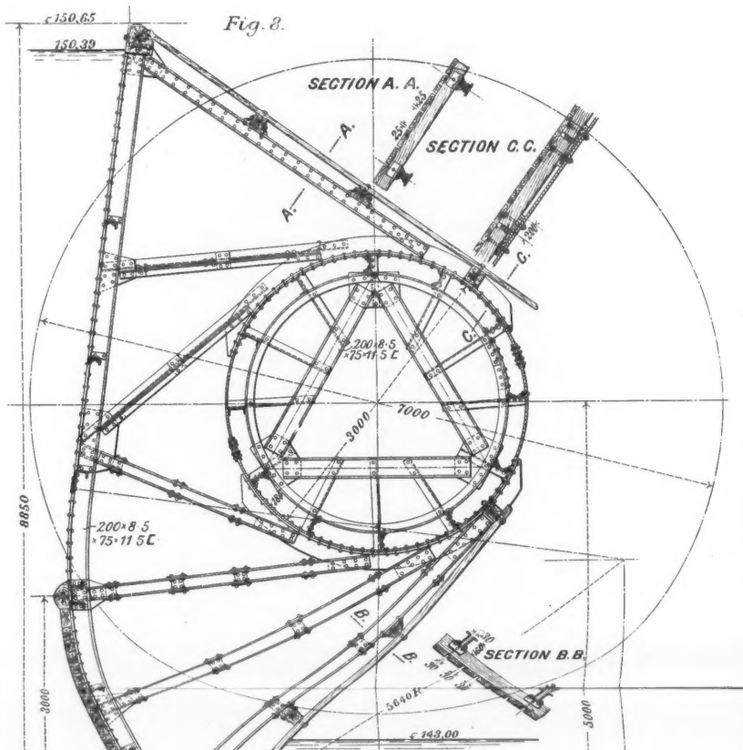


Fig. 9.

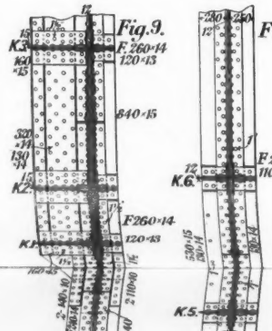
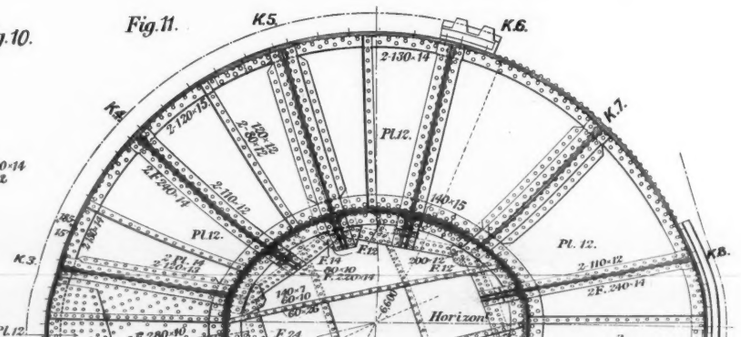
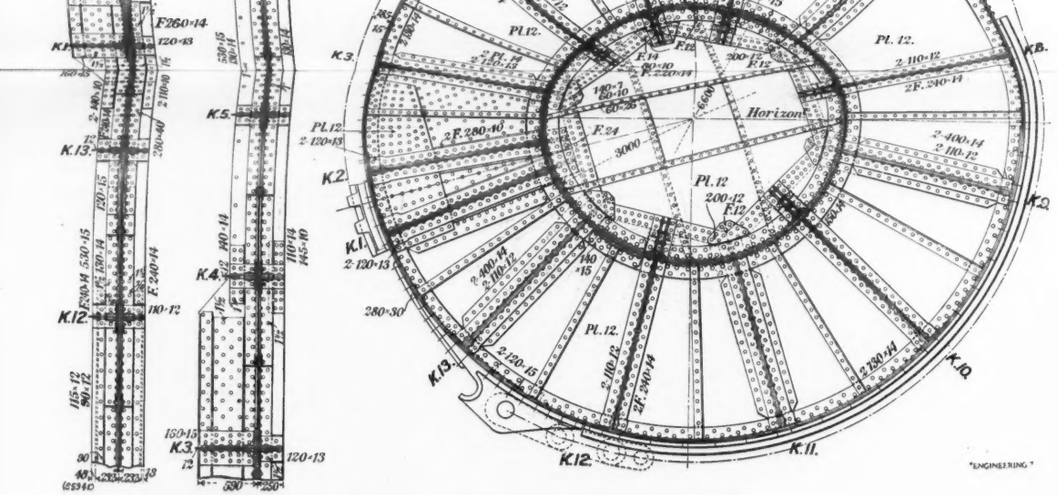
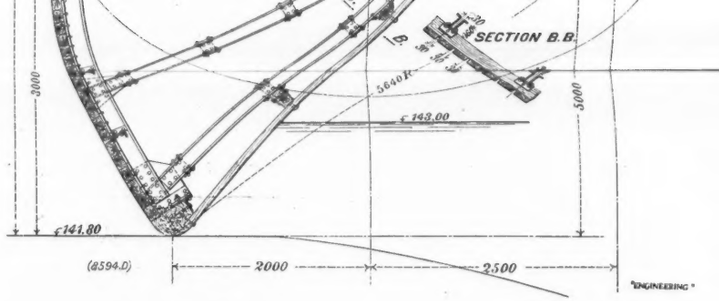


Fig. 10.

Fig. 11.







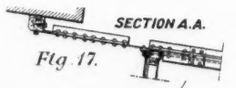


Fig. 17.

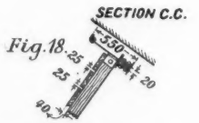


Fig. 18.

Fig. 16.

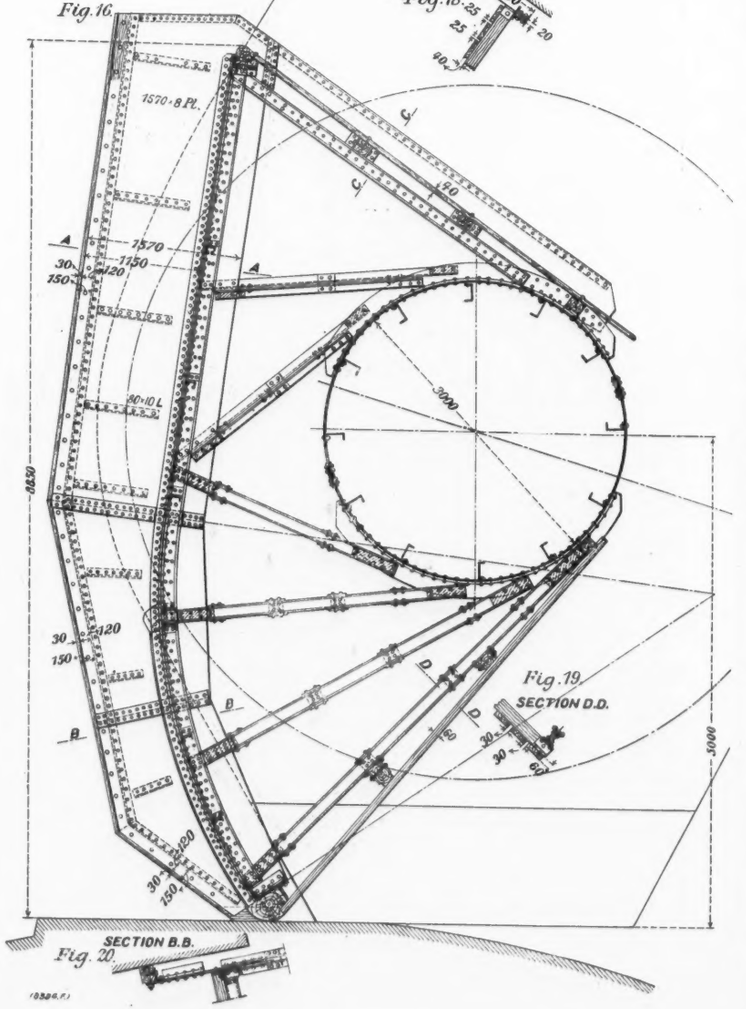


Fig. 19.

Fig. 20.

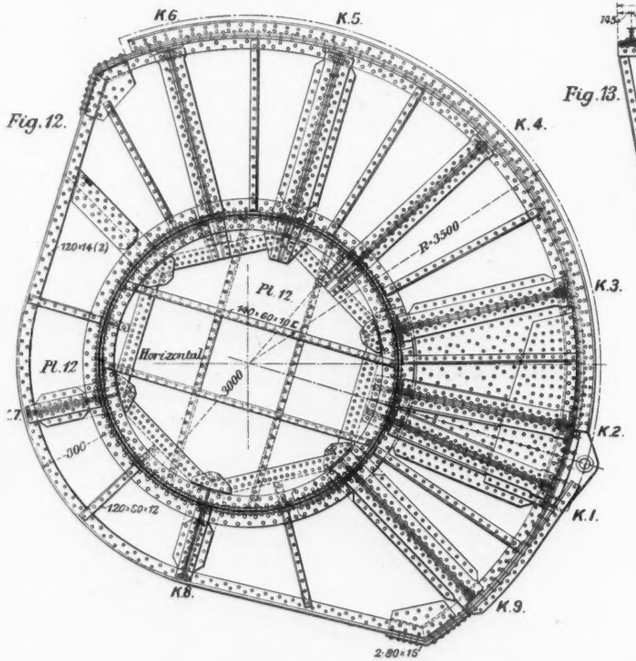


Fig. 12.

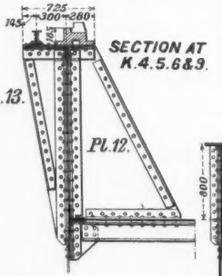


Fig. 13.

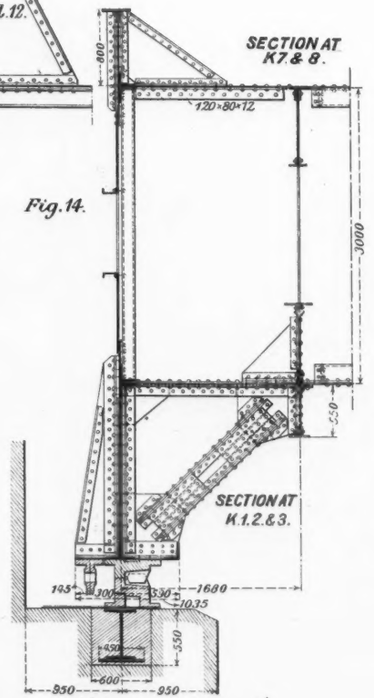


Fig. 14.

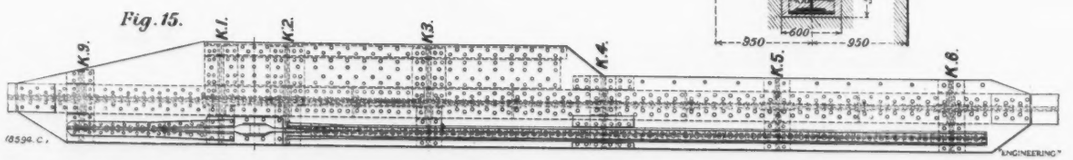


Fig. 15.

ROLLER DAM AT THE FORSHUVUDFORSEN HYDRO-ELECTRIC PLANT, SWEDEN.

(*For Description, see page* 6.)

FIG. 21. ONE OF THE PIERS WITH WINCH HOUSE.

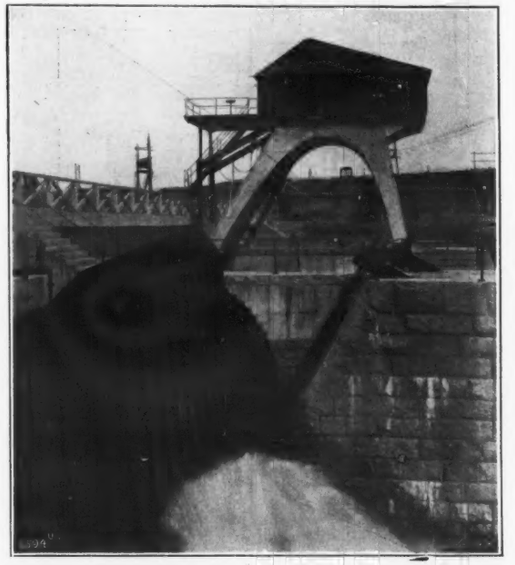


FIG. 22. THE INTERMEDIATE ROLLER PARTLY RAISED.

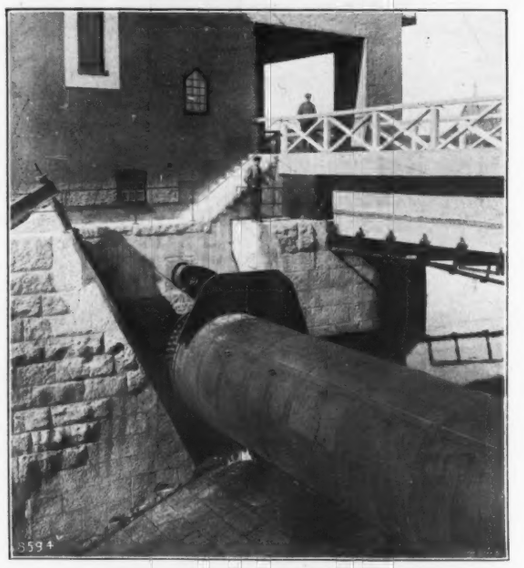


FIG. 23. FREE END OF SMALL ROLLER.

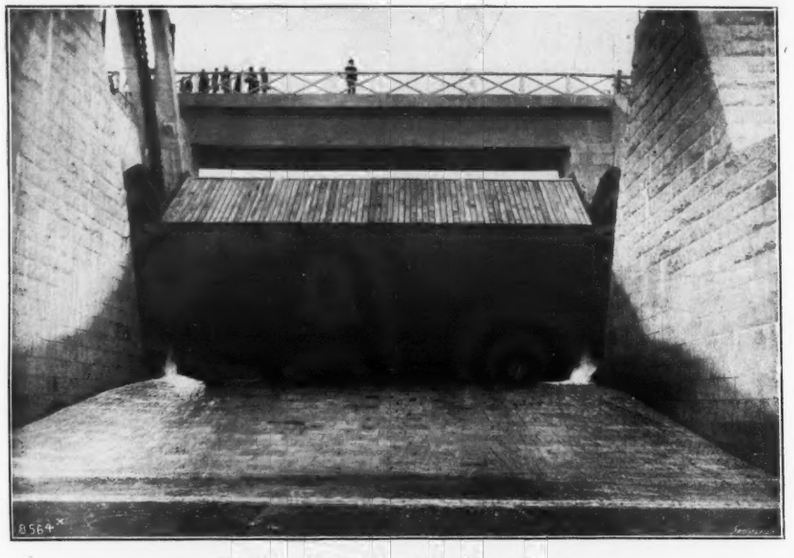


FIG. 24. ONE OF THE TWO LARGE ROLLERS.

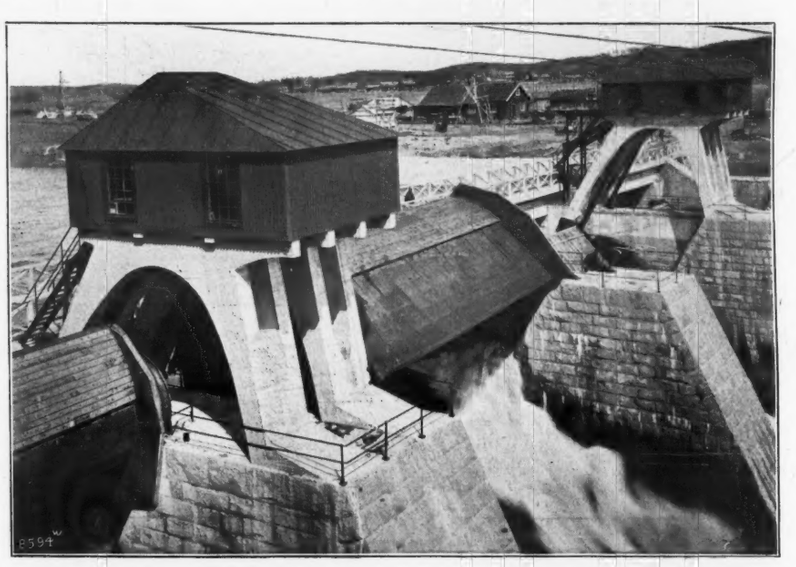


FIG. 25. THE WINCH HOUSES; SMALLEST AND INTERMEDIATE ROLLERS RAISED.

(*To face page* 7.)

ENGINEERING.

Offices for Publication and Advertisements, 35 and 36, Bedford Street, Strand, London, W.C.2.

We desire to call the attention of our readers to the fact that the above is our SOLE ADDRESS, and that no connection exists between this Journal and any other publications bearing somewhat similar titles.

TELEGRAPHIC ADDRESS } "ENGINEERING," WESTRAND, LONDON.

TELEPHONE NUMBERS—3663 and 8598 GERRARD.

SUBSCRIPTIONS, HOME AND FOREIGN.

"ENGINEERING" may be ordered from any newsagent in town and country and at railway bookstalls, or it can be supplied by the Publisher, post free, at the following rates, for twelve months, payable in advance:—

For the United Kingdom	£3	5	0
For Canada—			
Thin paper copies	£2	18	6
Thick paper copies	£3	3	0
For all other places abroad—			
Thin paper copies	£3	3	0
Thick paper copies	£3	7	6

Foreign and Colonial subscribers receiving incomplete copies through newsagents are requested to communicate the fact to the Publisher, together with the agent's name and address.

When foreign subscriptions are sent by Post Office Orders, advice should be sent to the Publisher.

ADVERTISEMENT RATES.

The charge for advertisements classified under the Headings of Appointments Open, Situations Wanted, Tenders, &c., is four shillings for the first four lines, or under, and one shilling per line up to one inch. The line averages seven words. When an advertisement measures an inch or more the charge is 12*s.* per inch. Payment must accompany all orders for single advertisements, otherwise their insertion cannot be guaranteed. Terms for displayed advertisements on the wrapper and on the inside pages may be obtained on application. The pages are 12 in. deep and 9 in. wide, divisible into four columns of 2¼ in. in width. Serial advertisements will be inserted with all practicable regularity, but absolute regularity cannot be guaranteed.

TIME FOR RECEIPT OF ADVERTISEMENTS.

Advertisements intended for insertion in the current week's issue must be delivered not later than First Post on Thursday. In consequence of the necessity of going to press early with a portion of the edition, alterations for standing advertisements should be received 10 days previous to the day of publication.

All accounts are payable to "ENGINEERING," LTD. Cheques should be crossed "The National Provincial Bank, Limited, Charing Cross Branch." Post Office Orders should be made payable at Bedford Street, Strand, W.C.2.

AGENTS FOR "ENGINEERING."

AUSTRALIA: Gordon and Gotch, Limited, Melbourne; Sydney; Brisbane; Perth. Angus and Robertson, Limited, Sydney, N.S.W. T. Willmett and Co., Townsville, North Queensland. W. C. Rigby, Adelaide, South Australia. Melville and Mullen, Melbourne, Victoria.

BELGIUM, Brussels: H. F. Satchell, 86, Rue du Tabellion.

CANADA, Toronto, Ont.: Wm. Dawson and Sons, Limited, 87, Queen Street East.

EDINBURGH: John Menzies and Co, Limited, Rose-street.

FRANCE, Paris: Boyveau and Chevillet, 22, Rue de la Banque. For Advertisements, Office de Publications Commerciales 167, Rue Montmartre, Paris (2e).

GERMANY: Hermann H. Fromm, Lützowstrasse 84, Berlin, W. 35. A Twietmeyer, Leipzig.

GLASGOW: William Love, 221, Argyle-street. John Menzies and Co., Limited, West Nile-street.

INDIA, Calcutta: Thacker, Spink and Co., Bombay; Thacker and Co., Limited.

ITALY: U. Hoepli, Milan. Anonima Libraria Italiana, Torino, and any post office.

LIVERPOOL: Mrs. Taylor, Landing Stages.

MANCHESTER: John Heywood, 143, Deansgate.

NEW ZEALAND: Gordon and Gotch Proprietary, Limited, Wellington, Auckland and Christchurch.

NORWAY, Christiania: Cammermeyer's Boghandel, Carl Johans Gade, 41 and 43.

ROTTERDAM: H. A. Kramer and Son, Limited.

SOUTH AFRICA: Central News Agency, Limited, Head Office—Johannesburg; and Pretoria, Cape Town, Port Elizabeth, Bloemfontein, Durban, and various branches and bookstalls throughout South Africa. Wm. Dawson and Sons (South Africa), Limited, 29, Long-street, Capetown.

TASMANIA: Gordon & Gotch Prop'ty, Ltd., Launceston: Hobart.

UNITED STATES: For Subscription, New York: W. H. Wiley, 440, Fourth Avenue. For Advertisements: J. S. Allan, 30, Church Street, New York.

CONTENTS.

	PAGE
Gas Engine Piston and Exhaust Valve Temperatures (*Illus.*)	1
Vibration of Steam Turbine Discs (*Illus.*)	2
Developments in Printing Telegraphy (*Illus.*)	4
Literature.—A Hundred Years of Portland Cement, 1824–1924. The Specific Heat of Gases	5
Water-Power Plant at Forshuvudforsen, Sweden (*Illus.*)	6
The Institution of Mechanical Engineers; Manchester Meeting	10
The Oxylene Timber Fireproofing Process (*Illus.*)	11
5/13½-Ton Fixed Electric Power Crane (*Illus.*)	13
Books Received	14
Notes from South Yorkshire	14
Notes from Cleveland and the Northern Counties	15
Notes from the North	15
Notes from the South-West	15
Notices of Meetings	15
The Expansion of British Markets	17
South Wales Gas Coal	18
The Stability of St. Paul's Cathedral	18
French Miners' Ownership Schemes	19
Notes	20
Wire Ropes Research (*Illus.*)	20
The Late Professor Liveing, F.R.S.	21
The Late Sir Andrew Ogilvie	21
The Sydney Harbour Bridge	21
Letters to the Editor.—Remuneration of Technical Men. "The Whitworth Scholarships." "Standards of Thermal Efficiency." Boiler Tests	21
Labour Notes	23
Year-Books and Annuals	24
Diagrams of Three Months' Fluctuations in the Prices of Metals	24
The "Cirplex" Drying Plant (*Illus.*)	25
The Hazards of Pulverised Fuel Systems	25
The Polar Two-Cycle Heavy Oil Engine (*Illus.*)	26
Die Casting (*Illus.*)	28
Illinois Central Railroad Electrification	30
Catalogues	30

One Two-Page Plate and Two One-Page Plates—HYDRO-ELECTRIC PLANT AT FORSHUVUDFORSEN, SWEDEN.

The Proprietors desire to announce that Major P. J. COWAN, M.B.E., M.I.Mech.E., Assoc.M.Inst.C.E., and Mr. H. H. JOHNSON, Wh.Ex., A.M.I.Mech.E., A.M.I.E.E., have been appointed Joint Editors of "ENGINEERING."

ENGINEERING.

FRIDAY, JANUARY 2, 1925.

THE EXPANSION OF BRITISH MARKETS.

AMONG the immediate measures which, in the interest of trade, Government and the industries must consider, none is of greater moment than the extension of trade within the Empire. Part of this development may take the form of buying British produce and products instead of foreign, but no programme will meet the needs of the present situation unless it provides also for the increase of both, and includes, therefore, means for developing British territories from which increased produce can be obtained. The existing capacity of British plants such, for instance, as those of the iron and steel and other branches of the engineering trades, would to-day suffice for a considerable extension of business.

To say that greater production goes with improvement in material well-being is an economic commonplace, which in principle is recognised generally enough. What in this country is not recognised so generally is the instant need for putting it into practice within the immense curtilage of our own Empire. With the onset of arrangements embodied in the Dawes agreement, and arising out of it, the attention of all industries has chiefly been drawn to the differences that will arise as compared with already established conditions of production and distribution. So far as concerns this country, and in particular its engineering trades, the overall effect may be summarised shortly. German industries have been carried on under the influence of immense advantages on the one hand, and of incalculably great handicaps on the others. By the extraordinary operation of the exchange they have practically wiped out the whole of their debenture or bond debt, estimated in 1913 at some 230,000,000*l.*, and in addition they have acquired a vastly enlarged and improved plant; on the other hand the uncertainty of the situation has had its natural effect in depressing the volume of business, and in creating a credit or money stringency that has compelled industries to pay fabulous rates for financial accommodation. Under the Dawes scheme they will retain the benefit of their plant, capable of producing economically an output greatly exceeding the utmost it has yet sold, and there seems little doubt that they will continue to have the advantage of cheaper labour and, where desirable, of longer hours than this country; but the Dawes industrial debentures to the value of 250,000,000*l.* will in effect reinstate their original mortgage debts, though the proceeds will be applied to reducing the amount of the German reparations debt. French and Belgian industries have also acquired enormous extensions of plant at much below their real value, and together with all other countries, are expecting to share the benefit of the extension of trading that must result from stabilised conditions in Europe and from the increased purchasing power in our own and other countries that will follow upon reduced taxation or other benefit consequent upon reparation payments.

These payments, however, can be made only out of the proceeds of the growth of German export trade. As a matter of vital national necessity Germany will accordingly strive to increase her share of that trade, and, with the United States, France and Belgium, to say nothing of Italy, in the possession of plants much larger and more efficient than before the war, especially in the engineering trades, our own country's share in the world's markets will be challenged with a competition that is likely to be formidable beyond all precedent. If the Germans do not succeed in securing a larger export trade than they enjoyed before the war, they will make default in the payment of reparations, and to the extent to which this occurs the stability of the present settlement, and the benefits expected to result from it, will suffer. The best prospect, therefore, requires success on their part in obtaining such an increase of business; and although in trade as it was before the war there may be a margin to enable them to do so, a very considerable increase in the volume of world trade will be needed if other producing countries are not to go short. In the engineering trades no country has such ground as our own for anxiety in this respect, for of the great producing countries none pays so much for its labour and its transport, works such short hours, or is so badly placed for making the best use of its labour.

It may be hoped that the immediate future may see some improvement in these last respects; but, supposing even that we were as well placed in regard to them as any of our competitors, we and other countries would still be unable to make any large increase in our share of foreign trade on its existing basis without jeopardising the trade out of which Germany has to pay its reparations. A large part, moreover, of our energy and resources would have to be devoted to working the machinery of competition, and thus be withdrawn from the directly useful purpose of increasing our production; and, regarding the world macroscopically, with each State as a producing and consuming unit, the world situation must remain as it is unless the aggregate of the products it has to divide is increased. Even with that aggregate increasing satisfactorily, the prosperity of an individual country must depend on that of the markets in which it is most firmly established; and so long as it depends on foreign trade, whether for the produce it consumes or the products it manufactures, that prosperity must fluctuate with the fortunes of its customers, and turn to adversity when they are sufficiently depressed.

Against this fundamental hazard of all countries whose prosperity depends mainly on their export trade, the States of the British Empire have at present a unique possibility of insurance if they adopt and consistently pursue the federal policy that is open to them. The United States, confined

to a quarter of a hemisphere, much smaller than the British Empire in area, population and resources, has shown how the cultivation of a home market of sufficient extent can enable a country not only to build up on that market a material prosperity without equal in the history of the world, but to dominate great export markets with the mere fringe and remnants of its production. If the home markets of British States were not restricted to their individual States, but extended to the whole of the Empire all over the world, the conditions of British trade would be analogous to those that have made and assure the prosperity of the United States. Geographically the States of the Empire have for this purpose the disadvantage of being bounded by the ocean instead of by land frontiers, and their trade is subject to the costs of ocean transport; but this, on the other hand, is cheaper than the land transport by which much trade between the several United States themselves has to be conveyed, and has the advantage of being distributed, not over a fraction of a hemisphere, but over the entire globe. Industries in competing countries are trying first one and then another mechanism for co-ordinating their constituent units, now by vertical and now by horizontal co-operation and with this object become entangled from time to time in complicated networks that add, not to the extent of production, but to the cost and delay of administration, and may leave the industries, or the constituent works, worse off in the aggregate than they were when they were separate. The adjustment of arrangements by which the entire Empire became the home market for all the produce and products of its constituent States would have exactly the contrary effect. It would increase the aggregate of the produce and products, and, while providing a basic market for them all, would place them in a position to claim their share of whatever export trade to foreign countries was to be divided.

Such arrangements would distribute their advantages over all the communities that were parties to them. Unlike schemes for the internal co-operation of industries, they would leave each source of production free to conduct its business in its own way, without introducing delay, expense or mutual restrictions, and the consuming communities would thus derive from them all the benefits of fair and healthy competition. The chief need of most parts of the Empire is, and for an indefinitely long period must be, the development of their vast untouched or imperfectly worked territories with the help of technical experience, men, and capital; and these the Home Country could find with advantage to itself. To co-operate with the rest of the Empire in such work would give this country, and first of all its engineering trades, fresh outlets and employment for its resources and inhabitants, and the most judicious opportunities of settlement for those of the latter that wished to seek a new home, and chose to get first to know it while engaged on the work. The results of such development and immigration would be to provide the territories affected with the means of satisfying a larger market and of spreading their overhead communal expense over a larger turnover, and to give the manufacturing elements of the combination not only present employment, but the assurance of increasing markets in the future.

With the stabilisation of European conditions all producing and manufacturing industries will be considering how to revise their international arrangements. If the assurance of an effective home market throughout the Empire is not included among the immediate agenda of the Government and the Imperial authorities, arrangements made by individual colonies with foreign countries may delay the present opportunity of inaugurating that policy, or may make such a policy permanently impossible.

SOUTH WALES GAS COAL.

THE rich coal deposits of South Wales are mostly non-bituminous, and the field is not particularly rich in seams suitable for continuous working in vertical retorts, blending being often necessary for satisfactory results. Nevertheless some of the East Glamorganshire and Monmouthshire collieries work on considerable bodies of bituminous coal, and are important sources of gas and house coal; and although as yet no systematic survey of the South Wales seams has been started, it has been thought desirable to obtain some knowledge of their gas-making qualities by making large-scale trials on a typical gas coal from that district. Under the advice of Mr. H. D. Madden, of the Cardiff Gas Light and Coke Company, the coal of the Meiros Collieries, Limited, Llanharan, was selected for the purpose, and the Fuel Research Board has just published an account of the trials and their results.* The Company supplied for the purpose 500 tons of uniform quality, the average unscreened output of the collieries, which consists of about 60 per cent. of the Pentre seam and 40 per cent. of the No. 3 Rhondda seam.

The trials were part of the series that the Fuel Research Board has been and is still making in connection with its physical and chemical survey of the national coal resources, with the object of determining the suitability for various purposes of the seams investigated. They were made on the experimental setting of four vertical gas retorts on the Glover-West system, installed at the Fuel Research Station primarily for studying the effects of steaming coal during carbonisation, a description of which has appeared in these columns (ENGINEERING, vol. cxv., pages 734, 761, and 811). The trials were conducted on the same lines as those of the Durham, South Yorkshire and Lanarkshire coals used in the last-named experiments and of the Arley (Lancashire) seam described more recently (ENGINEERING, vol. cxvi, page 565 and *supra* page 552). A further investigation on a Durham coal has been carried out at the request of the South Metropolitan Gas Company, and will be the subject of a forthcoming report.

The net results of the present trials is to exhibit the Meiros coal as a medium gas coal of a normal type. Without steaming it gave per ton of coal 12,000 cub. ft. of gas of a calorific value of about 540 B.Th.U. per cub. ft., or 65 therms per ton, about 6 per cent. more heat value than the Lanarkshire coal of the earlier trials, and about 5 and 9 per cent. less than the Durham and South Yorkshire coals respectively. The trials without steam could only be conducted for a short period—2 hours of actual gas making under test—as the temperature at the base of the retort has been found to be too high for the castings for any longer period of working without steam. It was, however, found possible to work the retort continuously on about 3½ per cent. of steam, and under this regimen to attain a steady working, when the steam was cut off for the two hours of the test proper. The gas made in that time served as a trustworthy basis for determining the effect of various percentages of steam (5, 12½ and 20 per cent.), and showed an increase of about 35 per cent. in the therms of the gas made with 20 per cent. steam, as compared with the unsteamed gas; this was about double the gain through steaming of the Durham coal gas, and about 5 per cent. more than the Lanarkshire coal gas, though about 10 per cent. less than the South Yorkshire. The quantities of coke and other products in this short run without steam were too small to be measured conveniently, but the yields with increasing quantities of steam were of the same order as had been obtained with other gas coals.

The most interesting feature of the report is the evidence it gives that the Fuel Research Station plant and methods are being brought under even better control than has been shown in earlier reports. It will be remembered that in the system of carbonisation used the retorts are heated by seven annular combustion chambers encircling them in pairs and arranged vertically above each other. In previous trials the figures showed wide variations between the temperatures of different chambers. In the present series no chamber in any trial differed from the mean temperature (1,256 to 1,259 deg. C.) by as much as 0·8 per cent., and the large majority were still closer. The weight balances, again, in which the coal, steam, and water (scrubbers) were balanced against the coke, gas, tar, and liquor left a loss varying in different trials from 0·39 to 2·38 per cent. This concordance is of the more importance, as it furnished an overall criterion of the trustworthiness of a trial, none in which any serious discrepancy appeared being regarded as satisfactory. The agreement is indeed closer than it seems, because on taking a balance between the water entering and leaving the system it is seen that almost the whole of the loss in weight balance is found in the water balance—indeed, in the trials with the higher percentages of steam rather more—, so that the bulk even of the small loss is referable to leakage of steam. The more difficult thermal balance, in which the potential heat in the coal was set against that of coke, gas and tar, showed a loss varying only from 2·25 to 4·20 per cent.

* Technical paper No. 10, Carbonisation of Coal in Continuous Vertical Retorts; a South Wales Gas Coal. H.M. Stationery Office [1*s.* net.]

THE STABILITY OF ST. PAUL'S CATHEDRAL.

THE laudators of past times, like the poor, are ever with us, and in each generation, from classical times, when the myth of the golden age was invented, down to the popular magazine writer of to-day, have deplored a steadily increasing degeneration in our standards and conduct. One of the most noted of these praisers of the past has embodied in verse his ideas of a constructional golden age "in the elder days of Art, when builders wrought with greatest care each unseen and hidden part." Recent investigations into the workmanship displayed in our great cathedrals, however, serves to show that this concept has as little basis in the actual facts as anthropological studies have shown to be the case with respect to the poetical fancy that mankind had fallen into want and misery from a primeval condition in which the earth yielded all fulness without toil. Extremely bad methods of building was disclosed in the execution of imperative repairs to Peterborough Cathedral, and it would seem that nearly equally reckless malpractices were exercised in constructing the eight great piers which support the dome of St. Paul's.

These, so far from being solid stone masonry, consist merely of a shell of this, some 12 in. thick, filled in with a conglomerate of various rubbish embedded in lime, and so lightly cemented by this that even to-day parts can be moved between the finger and thumb. Again, according to Sir Francis Fox, the foundation level is only 12 ft. below the surface of St. Paul's Churchyard, whereas the foundations of the adjacent more modern commercial buildings are 25 ft. below this level. It is not surprising, therefore, that very serious damage was done when, in 1831, the Corporation attempted to construct a deep sewer through the quicksands on the south side of the Cathedral and sunk a shaft at the foot of the South Transept to a depth of 20 ft. below the foundations of the Cathedral. The work involved heavy pumping, and "hundreds of tons" of sand and silt were thus removed. It is interesting to note that Sir Francis Fox records that Telford and Brunel strongly protested against this attempt, and that the work was abandoned in consequence. Great damage had, however, already been done. Artists and decorators were responsible for the next serious injury to the structure, and it is pitiful to add that this was effected during very recent years. In the interests of art it was decided to cut deeply into the great arches carrying the dome, in order "to give shadow" to certain decorative panels. The arches were already so much overloaded that it was noticed that each blow of the mason's hammer called forth a metallic ring and the chips flew off as if propelled from a gun.

It is not surprising that, in view of all these circumstances, it was found necessary, in 1921, to appoint a committee some, at least, of the members of which really understood structural matters, to report on the present condition of the Cathedral and to make suggestions for rendering the structure safe. A second interim report by this committee has just been issued. In this the

committee advise that as a first step the interior of the piers now filled with highly indifferent rubble should be grouted up with cement, on the plan which has been experimentally tried on the north-east pier. They state that whilst it is impossible to say that by this process the interior of the pier has been completely consolidated, sufficient has been done to strengthen it very materially, and the procedure would give a new life to the remaining piers at a reasonable expenditure of time and money. The cost is estimated at from 120,000*l.* to 140,000*l.* The Committee insist that the work is urgent and that if it is not vigorously pressed forward the situation may rapidly become grave. Sir Francis Fox, it may be added, has expressed the view that to attain permanent security the piers, after being thus strengthened, should ultimately be carried down to the London clay, but this work must be left to another generation, as the strengthening of the badly-built piers is a necessary preliminary to any ulterior operations.

FRENCH MINERS' OWNERSHIP SCHEMES.

THE tendency in France, commencing with the 'sixties of last century, has been directed not so much towards State ownership of the mines of the country as towards handing them over to the miners themselves. We know of three experiments in this direction, and in the belief that an account of these will prove interesting to many of our readers we give this briefly in the following. All three experiments were carried out in the Loire colliery basis, in the centre of France, the chief town of the district being St. Etienne, to the south-west of Lyons.

The first enterprise of the kind was that of the Ban Colliery, which was put into operation by the colliers in 1866. At that date the original owners were no longer making any profit; they anticipated losses in the very near future, and decided to suspend operations. They put up for sale their rights to the concession and their plant, and several of the leading miners they employed decided to take over the property. Several of their number felt that by acting on their own account, and by proceeding economically, they might succeed in winning to their advantage the coal remaining in the old workings and in their vicinity. They set to work in a very rudimentary manner, without engineers for carrying out surveys and for controlling operations. Each man undertook the job for which he deemed himself qualified. The miners finished by discovering important portions of coal seams, and prospered for a time. There were 10 partners at the head of the scheme, who worked together in harmony, and who did not advertise their doings. Coal, however, became scarce in course of time. From the year 1885 the scheme ceased to pay, and in 1887 eight of the partners sold their rights for a total sum of 6,000 francs to a neighbouring coal mining company, the two others entering the service of that company.

The second scheme was the Rive-de-Gier Miners' Ownership Association. It started in 1886 and had a more complete organisation than the Ban scheme. The private company which owned the concessions had experienced difficulties. It had paid no dividends since 1883, its reserve funds were exhausted, and it decided to close down. The local Miners' Federation thereupon resolved to obtain the grant of 12 of the concessions which had not yet been worked. They took these over towards the end of 1886, and a social contract of the miners was signed in February of the following year. After the settlement of difficulties which arose with the former owners, the miners proceeded satisfactorily for a short time. But difficulties soon cropped up, and were constantly recurring amongst the miners themselves. A division took place in their ranks, and the social contract had not been signed many weeks before the colliery was occupied and worked at one and the same time by two distinct miners' associations, one of which, the first in point of date, had right on its side, whilst the second formed of a more forceful body of men simply seized an important portion of the workings without any title to them whatsoever. The two workers' associations lasted down to 1895 and the result of their working was a loss. Wages were not paid in full, no dividends were ever distributed, and large sums were spent in the law courts.

The third experiment was that of the Monthieux colliery in the same basin. The owning company, an old-established one, was in a very bad situation financially in 1891, heavy sums having been expended without success in exploration work for gaining access to new seams. No dividends had been paid for many years. The capital being totally exhausted in 1891, the property was put up for sale in July of that year and the price asked fell ultimately as low as 50,000 francs. The Miners' Federation decided to purchase, and formed a company with a capital of 60,000 francs to start with, but the Federation incurred no expenditure, since 50,000 francs were contributed gratuitously by Mr. Marinoni, and local journals which had started subscriptions contributed the balance; moreover, the Paris Municipality voted a grant of 10,000 francs, and the Chamber of Deputies a credit of 50,000 francs. In the meantime statutes for working the colliery drawn up by the Federation were adopted unanimously by the miners in November, 1891. These statutes emphasized that capital would play no part in the association, there were to be no masters, the association was to be formed entirely of workers and to be an enterprise in which equality in exertion was to result in equality in remuneration. The scheme was to contain no loop-hole leading to class warfare, and complete solidarity and a perfect understanding were to prevail amongst all the co-operators. "The acquisition of the Monthieux colliery"—for which the miners did not pay one brass farthing—"was to demonstrate to the world the fact that the workers could easily dispense with the tutelage of the masters. . . It was all very well for the collieries of the country generally to secure the services of young engineers well versed in the theory of mining, but it was greatly preferable to be in a position to reckon upon the services of skilful practical men, able to lead an enterprise to a successful issue and without the exorbitant charges ruling amongst private companies. . ." The sale was completed at the end of February, 1892, and the acquirers—the Miners' Federation—undertook to pay an annual royalty to the concessionnaire; an annual sum of 9,000 francs to the adjoining St. Etienne Colliery Company, this being the contribution which the former Monthieux Company paid as its share in the drainage work; to continue the pensions and invalidity fund to the amount of 10,000 francs annually, and to deal with other charges, the total amounting in all to about 36,000 francs per year. The capital of the new concern was divided into 600 shares of 100 francs each, and each holder had one share. The statutes further stipulated that the Miners' Federation was to be paid 45 per cent. of the annual profits.

No sooner had the Association commenced operations than difficulties arose. The ten leading members of the new organisation elected themselves directors and resigned their membership of the Federation "in order to devote all their attention to the scheme." The colliery had not been working more than a few weeks under the new management when the ten directors endeavoured to render it independent of the Federation, but they had to reckon with the working miners, who all were members of that body, and were governed by it. The situation became so acute between the directors and the Federation that the 50,000 francs voted by the Chamber of Deputies and other sums, totalling 60,000 francs, were not paid into the scheme, as had originally been intended, but were distributed by the Government authorities to the unemployed miners of the district and to local benevolent funds. In May, 1892, about six months only after the adoption of the statutes, the dispute between the Federation and the directors came before the Courts. Shortly afterwards two of the directors were prosecuted for a breach of the law governing the use of explosives in mines. In July, 1892, the ten directors had to resign, the Federation took over the management and allotted the available shares to its members. But the scheme gradually became again independent of the Federation, the disunion in this second instance being due to the attitude taken up by the non-working members. The Federation, moreover, had become dissatisfied with the financial situation of the concern, and ultimately severed its connection with it, leaving it to extricate itself as best it could. The Association thus lost the trade unionist character which it held as an offspring of the Miners' Federation.

In this second phase of the Association's existence there were other difficulties which were brought before the Courts in 1894 and 1901. Towards the middle of 1893, the working miners were insufficient in number, and in order to supply the demand for coal, more were taken on by the management in the capacity of "auxiliary hands." A year later, in May, 1894, these latter claimed to be placed on the same footing as the original members, according to the statutes, but this claim was not allowed, since it would have meant an increase in the number of men sharing the profits. The Court decided against the management, adding that although the shares were all allotted, the Association remained bound with regard to the claimants, who were awarded damages. From 1894 the concern worked for some time at a loss, and wages were not regularly paid. Many original members thereupon resigned, and their shares were allotted to the remaining original members. Other "auxiliary hands" were taken on to fill the vacancies and these also claimed in due course the privilege of full membership. This was refused, the management stating that the new hands had been "purely and simply taken on according to the rules generally governing employers and workmen." At this juncture a specially-active member of the Board gave a fresh impulse to the work, matters improved and profits were made down to the year 1901. It should be remarked here that the original statutes were modified in 1900. In January, 1901, the "auxiliary hands" brought before the Court their claim for participation in the profits; this was dismissed in June of the same year. As will be seen, the Association had become a capitalistic body.

"Equality in exertion" never led to "equality in remuneration." What had occurred was simply the taking over of a colliery by a small group of employers, the miners being merely workers in their pay. The association, almost as soon as it was formed, became the adversary of the Miners' Federation, who had established it in the first place. The association declined rapidly from 1903 onwards; it finished by encroaching upon the neighbouring concession belonging to another company; all the plant having a marketable value was sold; sums set apart for the pension and invalidity funds were diverted to other purposes, and the association was declared bankrupt in 1909.

From the above it will be seen that the experimental management of collieries by the colliers failed entirely. The advocates of such a procedure cannot argue in its favour by holding forth the comparative success which attended the working by the miners of the Ban colliery, the first scheme in point of date. In this first scheme the men were not imbued with any social theory, the applicability of which they desired to demonstrate. The group at the Ban colliery consisted of a small number of industrious workers who had purchased in the open market, with their own means, a mining concession as they would have purchased a field or any other property, and they worked it with their own resources and by bringing to bear the experience they had gained during long years of work.

Detailed particulars of the three schemes were issued some time ago by Dr. Bréchignac, a lawyer of St. Etienne, and it was to be anticipated that no further attempt would be made on similar lines. Such, however, has not been the case, and news reaches us of a fourth and much more recent experiment, that of the slate quarry of the Hôtellerie de Flée, in the Angers slate quarry district. The concern in this instance was the Aura Association, having a share capital of 1,000,000 francs, and a bond issue of 400,000 francs, subscribed by the Miners' and Slate Quarrymen's Federation. The whole capital has been swallowed up, according to a recent statement made by "Comrade" Bartuel, the General Secretary of the Federation.

NOTES.

THE NEW YEAR HONOURS.

THE recognition by His Majesty the King of distinguished service in various fields which is always a pleasing feature of the incoming of the New Year will, on this occasion, afford satisfaction to all who know and appreciate the value of the work done by those recipients of honours who occupy positions in the fields of science and engineering. In the list published yesterday there are some names which give evidence of an appreciation of the merits of men who have long ago won the admiration and esteem of their colleagues. To those who recognise the value of the many and valuable contributions made by Sir Ernest Rutherford to our knowledge of the constitution of matter, the bestowal of the Order of Merit will be regarded as a fitting tribute. The engineers of this country will derive special pleasure from the recognition of the work of two men who, by their leadership in the councils of engineering associations, have done much to safeguard the interests of engineers and to extend the production of British engineering works. We refer to Mr. Benjamin Longbottom, of the British Electrical and Allied Manufacturers' Association, and Mr. Ernest W. Petter, of the British Engineers' Association. Their efforts are well known, and it is very gratifying to the engineering profession that knighthoods have been conferred on these two trusted leaders. Others who have received the same honour are Col. John W. Pringle, the Chief Inspecting Officer of Railways in the Ministry of Transport, and Mr. Frederick St. John Gebbie, the Consulting Engineer to the Government of India. Recognition of his merits as a chemist and as Principal of St. Andrew's University, has been given to Dr. J. C. Irving, whose name is also included in the list of knighthoods. Viscount Cowdray, the head of the firm of Messrs. S. Pearson and Son, has been awarded the Grand Cross of the Royal Victorian Order. Of the others in the honours list, the inclusion of whose names will give pleasure to engineers, are Mr. Leopold H. Savile, the Civil Engineer-in-Chief of the Admiralty, who received the C.B.; M. William Cattanach, the Chairman of the State Rivers and Water Supply Commission of Victoria, who has been awarded the C.M.G.; Mr. Ernest G. Turner, of the Bombay Improvement Trust, and Mr. Frederick Anderson, of the Irrigation Branch of the Public Works Department in the United Provinces, both of whom have been granted the C.I.E.

MANCHESTER COLLEGE OF TECHNOLOGY.

In commemoration of a century of useful work in the training of engineers, chemists and others associated with technical industry, a series of social functions was held in the Manchester College of Technology on Thursday, December 18, and the following days. The College came into existence in the natural process of development of the work of the Mechanics' Institution, which was founded in 1824 by men of great foresight, amongst whom were William Fairbairn, Richard Roberts, Benjamin Heywood and William Wood. Manchester engineers have always been pioneers in every movement making for future well-being, and this was well demonstrated when the legatees of Sir Joseph Whitworth, decided to establish a Whitworth Institute of Art and Industry of which a Technical School and School of Art were to form integral parts. The passing of the Technical Instruction Act of 1889, however, gave the Local Authorities power to levy rates in their areas for purposes of technical education, and the Governors of the Whitworth Institute, recognising the benefits to be derived from taking advantage of this, decided to transfer the purely educational part of their work to the Manchester Corporation. As the Governors of the Whitworth Institute had already prosecuted inquiries into the development of technical education abroad, they were convinced of the necessity of a great extension of activity in Manchester, and the legatees of Sir Joseph Whitworth handed over the site of their old works in Sackville-street for the erection of the present buildings. In the course of visits by the Principal of the College, Mr. J. H. Reynolds, and some members of the committee of the new institution, to America and Canada, Dr. John T. Nicolson, of McGill University, Montreal, was invited to go to Manchester as head of the engineering department and to design suitable equipment for the laboratories. To him and to Sir William Jackson Pope, who was appointed Professor of Chemistry, the main work of placing the college among the best equipped in the world was entrusted, and the confidence in them that was shown by the Governors proved to be well merited. Dr. Nicolson's work was continued by Professor A. B. Field and later by Professor G. Gerald Stoney, and on this side the reputation of the College has been well maintained. The electrical department was greatly strengthened by the appointment, in 1912, of Dr. Miles Walker to the Professorship, and under his inspiring influence this department has become one of the most important. Hopes are entertained of great extensions of the College in the future and funds are now being raised for the purpose.

THE TRAINING OF APPRENTICES.

Whilst it is probable that few, if any, private firms, can compare with the dockyards in the advantages offered to the more capable apprentices, the scheme for training the latter, which has been adopted by the Huddersfield Engineers' Training Association, seems to embody some admirable features. The Association was formed to provide for the better training of apprentices, in the engineering and allied trades, an aim which in the past has been greatly neglected by certain firms, who showed themselves very reluctant to do their fair share in educating and training the rising generation of engineers and mechanics. These defaulters were possibly actuated by the belief that a supply ample for their requirements would always be forthcoming from shops where less narrow views prevailed. To-day there is perhaps some danger of a shortage of apprentices, in view of the great attractions of the sheltered trades, which in some cases have hardly stopped short of blackmailing the public, into according them a privileged status unwarranted by either their abilities or responsibilities. It is, therefore, increasingly important that the "industrious apprentice" should receive adequate encouragement. To this end the Huddersfield Association aim to ensure to apprentices a proper practical training in their respective trades. They endeavour, in addition, to secure uniformity of action on the part of the employers concerned. Those who have joined the Association are in fact pledged to give certain facilities to their apprentices. To encourage the latter to attend the evening classes at the Technical College, the Association offers annually one gold, two silver, and three bronze medals for the best students in the Diploma course. In addition, satisfactory apprentices are given prizes which may be partly in cash, and also higher rates of wages. Shop training is by no means neglected in the scheme. Indeed, the marks on which apprentices are rated by the shop management, provide for a maximum of 150 marks per annum for class work as against 200 marks for workmanship, 100 for conduct and 100 for time keeping. The number of hours spent at class work is paid for at the shop rate of ordinary wages, provided that the home work, progress reports and examination results are satisfactory. No limit is set to the number of classes which may be attended, but it is stated that three is probably as much as can be efficiently undertaken. Those apprentices who obtain not less than one first-class award and one second-class award in the second or third years' engineering course at the Technical College, are allowed one afternoon per week off for attendance at a special apprentice class. The time there spent is paid for at the shop rates and the class fees are met by the employer. The Association, it may be added, have an advisory committee which assists the governors of the Huddersfield Technical College in any reorganisation of the section that may be required.

IMPACT TESTS AT LOW TEMPERATURES.

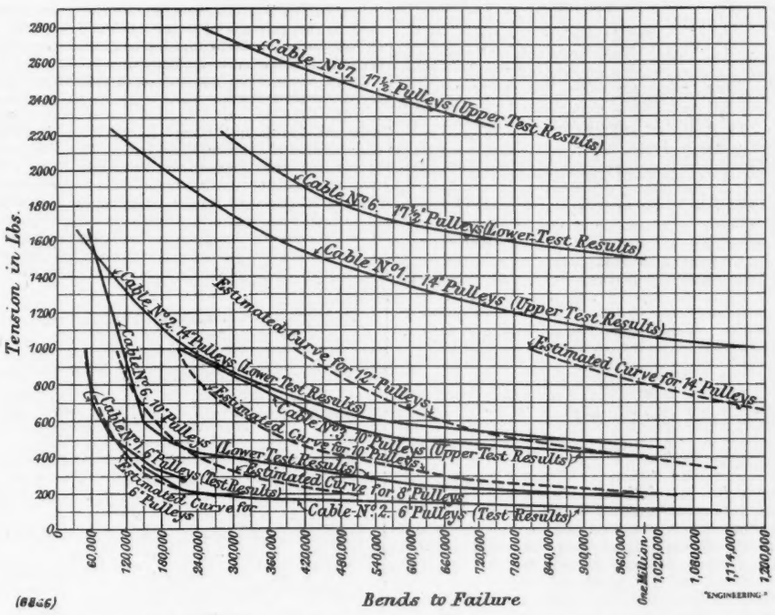
It is never possible exactly to reproduce, in the mechanical testing laboratory, the conditions which materials undergo while in service, but engineers are becoming increasingly aware of the necessity of imitating such conditions to the utmost possible extent. The closer this approximation the greater will be the value of the results obtained. The fact that exposed parts of aircraft flying at considerable altitudes attain temperatures much below the normal has led the Aeronautical Research Committee to conduct a series of experiments with a view to determine the change in properties produced in steel when the temperature is lowered to — 40 and — 80 deg. C. A detailed account of this investigation carried out by Dr. L. Aitchison and the staff of the engineering department of the National Physical Laboratory is given in the Committee's "Reports and Memoranda, No. 922" (published by H.M. Stationery Office. Price 9*d.* net.). The report is entitled "Notched Bar Impact Tests at Low Temperatures." A mass of figures is given, and the consideration of these show that the investigators have taken every step to make their experiments exhaustive and complete. The general conclusions arrived at are as follows: "The results appear to show that the hardened and tempered nickel-chromium steels and the hardening steels are less susceptible to the effect of low temperatures than are the plain carbon steels, whether the latter have been hardened and tempered or merely normalised. The majority of the plain carbon steels tested give a marked drop in the notched bar value at low temperatures below that obtained at air temperature. Cold-worked materials depreciate very seriously in notched bar value, with the fall in temperature." To give a few examples: A 0·40 per cent. carbon-steel after suitable quenching and tempering gave an impact value of 6·8 ft. lbs, at 17·5 deg. C.; 3·7 ft. lbs. at — 40 deg. C.; and 3·0 ft. lbs. at — 80 deg. C. A 3 per cent. nickel-steel containing 0 5 per cent. chromium, oil-quenched at 850 deg. C., and water-quenched at 500 deg. C., gave impact values of 8·9, 8·5, and 8·2 ft. lbs. at 18, — 40, and — 80 deg. C., respectively. A series of tests carried out on a 100-ton air-hardening steel gave results which were on the whole uniform, but in which the marked influence of the tempering temperature could be traced. In the case of a cold-worked 0·42 per cent. carbon-steel the impact value dropped from 6·4 ft. lbs., at 15 deg. C., to 3·6 ft. lbs., at — 80 deg. C. The report does not enter into theoretical considerations. It has long been known that changes occur in steel well below the lower critical range, and these results again force on us the fact that whereas we are fairly familiar with high temperature changes our knowledge of what occurs below the Ar_3, $_2$, $_1$ line is limited. In spite of the large amount of research carried out, the thermal equilibrium diagram of the system iron-iron carbide is still incomplete. It appears to be assumed in the report that specimens return to the normal, as regards impact value, if allowed to warm up again to room temperature from the region of — 80 deg. C. It would be of interest to know whether the micro-structure had been affected by these conditions, or whether the crystalline space lattice had been altered in any way during exposure to low temperature. Another point is the possibility of serious stresses being set up within the metal by the intense cooling. If this occurs it would be worth while examining this aspect of the question to see if any definite relation existed between them and the drop in impact value. The fact that cold-worked materials depreciate "very seriously" may possibly be due to some unexplained action of the amorphous matter present. At present conjectures only can be made on such points. The question is one of importance, and it is clearly desirable that it be probed further.

WIRE ROPES RESEARCH.

IN connection with our report of the recent meeting at the Institution of Mechanical Engineers, at which the Second Report of the Wire Ropes Research Committee was considered, we mentioned that Mr. Daniel Adamson, now Chairman of this Committee, had prepared two charts, summarising the results so far obtained, and showing how these fell in with an approximate rule adopted by himself.

The first chart, with tension plotted against the number of bends required to produce failure, showed

WIRE ROPES RESEARCH.


Tension in Lbs.
Bends to Failure
Cable No 7. 17½ Pulleys (Upper Test Results)
Cable No 6. 17½ Pulleys (Lower Test Results)
Cable No 1. 14" Pulleys (Upper Test Results)
Estimated Curve for 14" Pulleys
Cable No 2. 14" Pulleys (Lower Test Results)
Estimated Curve for 12" Pulleys
Cable No 3. 10" Pulleys (Upper Test Results)
Cable No 4. 10" Pulleys (Lower Test Results)
Estimated Curve for 10" Pulleys
Cable No 5. 8" Pulleys (Test Results)
Estimated Curve for 8" Pulleys
Cable No 8. 6" Pulleys (Test Results)
Estimated Curve for 6" Pulleys
One Million
"ENGINEERING"

curves, representing all the Committee's results, to have a general similarity. The second chart we now reproduce above. In this, Mr. Adamson has had plotted the extreme results for different sized pulleys, according to the results of the Committee's investigations. In addition, on this chart he has shown, in dotted lines, hyperbolic curves using different constants. The empirical rule he had adopted had been worked out for the limits only of between 1,000 lb. and 200 lb. tension, and up to one million bends. The constants selected for his $x \times y = C$ formula, were as follows for different diameter pulleys :—

Pulley. in.	Constant.
6	50×10^6
8	100×10^6
10	200×10^6
12	400×10^6
14	800×10^6

Starting from the 1,000-lb. line hyperbolas had been drawn in and the agreement of these with the Committee's results will be seen to be very good. The curve for the 6-in. pulleys practically coincides with the curve of the test results. The Committee made no tests on 8-in. pulleys, but the empirical curve for such a pulley falls on the Committee's lowest curve for 10-in. pulleys. Mr. Adamson's curve for 10-in. pulleys falls fairly for the most part in the area bounded by the Committee's lowest and highest curves for pulleys of this diameter. The 12-in. pulley curve lies approximately on the lower 14-in. test curve. Lastly, Mr. Adamson's curve for 14-in. pulleys lies well in the area bounded by the extreme curves of the Committee's tests. The agreement in all cases appears to be sufficiently good to support Mr. Adamson's suggestion that the chart might form a reasonable guide to designers and gives support to his rough theory that increasing the diameter of the pulley by two rope circumferences would double the life of the rope.

In this connection we would like to take the opportunity of pointing out that some confusion has arisen in our report on Mr. Adamson's remarks on crane pulleys, through the Committee's work being conducted with 1-in. ropes. Mr. Adamson's crane pulley sizes were referred to rope circumferences, a diameter of 6 rope circumferences being normal, 7 liberal, and 8 generous.

THE LATE PROFESSOR LIVEING, F.R.S.

THE veteran Cambridge chemist, Professor G. D. Liveing, who died on December 26, a few days after his 98th birthday, was almost forgotten outside Cambridge and St. John's College. There he remained a familiar figure until two months ago, when he was knocked down by a bicycle. Apart from his long connection with Cambridge, where he resided for 76 years, and with his College, which elected him a Fellow in 1853, he will chiefly be remembered as the originator of experimental science teaching at Cambridge University, and as the collaborator in photochemical research of Sir James Dewar, whom he survived by nearly two years, and who was his junior by 15 years.

George Downing Liveing was born at Nayland, Suffolk, on December 21, 1827, entered St. John's College in 1847, and, after having for one semester worked at Berlin under the great mineralogical chemist Rammelsberg, was in 1853 given, together with his Fellowship, also a college lectureship in natural science, an altogether novel appointment, Provision was also made by his college for practical instruction. This was not, however, the first case of such instruction in England, for in the same year 1853 the Royal School of Mines at South Kensington had taken over the private school of chemistry and the laboratory in Oxford-street where August Wilhelm Hofmann had been training W. H. Perkin and others for some years. The facilities for practical teaching at St. John's and, after 1863, in the Cambridge University laboratory were, as in all these institutions, exceedingly modest at the outset. Liveing became for one year professor of chemistry at Sandhurst, without leaving Cambridge, and married in 1861. He also became James Cumming's successor as professor of chemistry. His marriage involved resignation of his college Fellowship, but he was elected a Professorial Fellow, and in 1911 president of St. John's College. His work was largely physical; together with James Dewar, who became Jacksonian professor of chemistry in Cambridge in 1875, he conducted for a quarter of a century the systematic spectroscopic research for which the Royal Society awarded them jointly the Davy medal in 1901. He had been elected Fellow of the Royal Society in 1879. These researches were published in 1911 under the title "Collected Papers on Spectroscopy." The new laboratories of the chemical school at Cambridge, opened 1888, were built to Liveing's design. He resigned his chair in 1908. Liveing's other activities were mainly directed to the interests of his university, and these, especially his earlier years, brought him into contact with many men of note.

THE LATE SIR ANDREW OGILVIE.

MANY of our readers will share the regret with which we record the death of Colonel Sir Andrew Ogilvie, R.E., who in addition to his duties at the Post Office, was for six years Director of Army Signals (Home Defence). During the war he was largely responsible for the telegraphic and telephonic communications between the forces in Great Britain, including the anti-aircraft defence lines and the prompt distribution of air raid warnings by telephone to points of strategic importance, munition factories and public institutions. He was also responsible for providing technical *personnel* for the Royal Engineers Signal Service, recruiting some 600 officers and 20,000 skilled men for signal work on the various fronts, and for co-ordinating the Post Office Stores with the Army Signal Service of all the forces oversea. After prolonged experience as private secretary to Mr. Fawcett and succeeding Postmasters-General in his earlier career, he acquired experience of telegraph organisation and the inception of the Post Office telephone service, and the ultimate acquisition of the system of the National Telephone Company was carried out largely under his guidance. Not trained as an engineer, he was constantly anxious for the assistance of those who were, and interested himself keenly in the technical history of telegraphic and telephonic development. He was intimately familiar with the methods of his department, and he used his knowledge to prevent them, wherever it was possible, from impeding its service or interfering with the convenience of the public, or even of individuals. He was, in fact, an able and experienced administrator with a singular freedom from the characteristic weaknesses of the bureaucrat; and his urbanity, firmness and high personal character will long be remembered by those who met him in his official work.

THE SYDNEY HARBOUR BRIDGE.

IN commenting on Mr. Bradfield's able and highly interesting report on the plans for the great arch bridge at Sydney we suggested (see ENGINEERING, August 1, 1924, page 170) that he had been somewhat hasty in so trenchantly condemning the special steels which Sir William Arrol and Co., Limited, had proposed to use in the designs submitted by them for the structure in question. The working stresses adopted by these highly experienced bridge builders and their consultants were declared by Mr. Bradfield to be "too great for the material proposed." The charge implied in this statement is a somewhat serious one, and Messrs. Arrol have naturally felt unable in justice both to themselves and their consultants to let the matter rest uncontested. They accordingly submitted authoritative test results to Professor W. H. Warren, Dean of the Faculty of Engineering in the University of Sydney and obtained his opinion. In a letter published in *The Commonwealth Engineer* of November 1 last Professor Warren, having examined the data supplied to him, states that he considers "the special steel proposed more than fulfils the requirements of the specification and the working stresses were not too high." He takes the view suggested in our article that Mr. Bradfield had assumed that the "limit of proportionality" specified by Messrs. Arrol was identical with the yield point and was misled accordingly. We give below the test results submitted to Professor Warren :—

Tests made at the Royal Technical College, Glasgow, on Special High-Tension Steel offered by Sir William Arrol and Co., Limited, in their Tenders for Sydney Harbour bridge and Manufactured by Messrs. Wm. Beardmore and Co., Limited, Parkhead Forge and Rolling Mills, Glasgow.

A quality for structural work not requiring heating.
B quality for structural work requiring forging or welding.

	A. Quantity.		B. Quantity.	
	Tons per sq. in.	Lb. per sq. in.	Tons per sq. in.	Lb. per sq. in.
Limit of proportionality ..	23·1	51,744	25·85	57,904
Yield stress ..	24·6	55,104*a*	28·04	68,810*a*
Ultimate stress	37·3	83,522*d*	39·63	88,771*d*
Modulus of elasticity ..	13,527	30,300,000	13,410	30,038,400
Extension in 8 in.	22·8*b* per cent.		21·9*b* per cent.	
Reduction at fracture ..	62·2*c* per cent.		Not given.	

a Minimum yield point for structural nickel steel as given in Clause 87 of the Sydney Bridge specification is 50,000 lb. for plates and shapes and 45,000 lb. for rivets.
b Minimum extension on 8 in. specified is 1,600,000 divided by the ultimate stress, which in this case would be 1,600,000 divided by 83,522, which equals 19·2 per cent. for A quality, and 1,600,000 divided by 88,771, which equals 18·0 per cent. for B quality.
c Minimum reduction of area specified is 40 per cent.
d Ultimate stress specified is 85,000 to 100,000 lb. for plates and shapes and 70,000 to 80,000 lb. for rivets.

LETTERS TO THE EDITOR.

THE REMUNERATION OF TECHNICAL MEN.

TO THE EDITOR OF ENGINEERING.

SIR,—There appear to be several of your readers who take exception to the remuneration offered by the Royal Aircraft Establishment at Farnborough, and consider that it is altogether inadequate; but the writer ventures to think that the suggested pay is much superior to that generally the lot of technical men. One rather thinks that these readers who are responsible for the outcry are not very well informed in regard to pay generally in the engineering profession.

Naturally the large firms and corporate bodies

are going to get the best men for the least possible money, and as there are about 500 applicants for every vacancy they get the price as low as possible.

As an example for comparison, there is one well-known engineering firm who pay to the heads of the departments the very low sum of 200*l.* to 250*l.* per annum. These men are experts in their profession, and of from 15 to 20 years' experience, and generally hold the extra first-class certificate (Board of Trade), which may be considered as the honours degree in marine engineering. They are also expected to appear at the office well dressed, so as to create an atmosphere of personal prosperity in the presence of clients or prospective clients of the firm, from which, of course, the firm benefit. Fortunately these men generally have some private means beyond their remuneration, and so the deception to the client continues.

The writer wonders how many of the present generation now entering on life's way, and selecting the engineering profession, realise how poor in promotion and pay will be their lot? Do they appreciate the meaning of the case of the men in the firm above mentioned, when applied to themselves? Do they imagine their feeling (supposing they have no private means) when they are, say, 40 years of age, and receiving the munificent salary of some 200*l.* to 250*l.* per year, while they can see a young man of 21 years already getting 150*l.* as a bank clerk?

It will be said that the firm hereinbefore referred to are unduly parsimonious and mean; that, of course, may be, as they rather pride themselves on having the poorest-paid technical staff, but even then the prices might be much higher and then would not approximate to equivalent responsible posts in other walks of life.

I will cite one other instance for comparison. A young man of the writer's acquaintance was trained in the best technical college in London, then served his time in one of the best marine engineering firms in England. He is now at sea as fourth engineer in a steamer carrying 10 engineers. His pay is 13*l.* per month, while a stoker gets 10*l.*, but the stoker only works eight hours per day, while the fourth engineer seldom does less than 12.

The root base of the trouble is the engineers themselves. There are about 50 where there is one required, and the sooner the technical colleges close their doors the better, as they only more and more flood the market with engineers that are engineers only in name, and only flood the market and spoil the possibilities of those who are really born engineers.

I would take this opportunity strongly to urge all young men who have any leaning towards our profession to turn to other industries in life if they would like to be successful. They will find engineering all right as a hobby, but as a means of existence hopeless.

Yours faithfully,

December 30, 1924. ENGINEER MANAGER.

"THE WHITWORTH SCHOLARSHIPS."

TO THE EDITOR OF ENGINEERING.

SIR,—I have read from time to time in ENGINEERING some trenchant and not undeserved criticisms of the University Graduate in the engineering profession. Many of the remarks in your leading articles and correspondence columns are, unfortunately, very true. It is obvious that the Universities are turning out an ever-increasing stream of hopeful young men, whose sole claim to the consideration of possible employers is the possession of a degree, and, therefore, a certain standard of theoretical knowledge. Some of them proceed to pass through the mill of shops and drawing office, where their book knowledge certainly helps, and they eventually become competent engineers. Others, however, have been led by enthusiastic teachers into the belief that a degree is a passport to all that is desirable in the engineering profession. They are speedily disillusioned, but the number of such men is continually increasing and tends more and more to lower the status of University training, as well as the status of the man who hopes, by accumulating qualifications other than those attained by years of practice in the peculiarly thankless and unremunerative work of the engineer, to advance himself in the profession he has chosen. Unfortunately, the policy of ENGINEERING seems to decry the University degree.

A letter signed "Not a B.Sc.," has recently been published, which, if taken seriously, would actually make the possession of a degree detrimental to anyone applying for a post. Undoubtedly, injustice is being done to that large section of University Graduates, many of whom qualified as external students of their Universities, while earning their living by day as practical engineers. Such men had an idea that a degree was at least a guarantee that they had a sound theoretical knowledge of the great principles underlying the collection of small detail jobs that constitutes the working life of most junior members of the craft. All cannot be eminent men, responsible for the design and carrying out of great undertakings or the development of original ideas that ultimately revolutionise important branches of the industry of the world. From many, these things are withheld. They are hewers of wood and drawers of water, perhaps working out details of other people's ideas, or (more heartbreaking and monotonous still) merely maintaining in a more or less efficient state some industrial plant that other brains have designed.

Yet a knowledge of the approximate theory of the strength of materials and structures, the classic theory of the heat engine and the underlying principles of electrotechnics cannot be a drawback, even to a practical engineer, and such knowledge is conferred by a University degree. Therefore, it is to be hoped that the disparagement that has been the sole reward of many unfortunate engineers, who are also graduates, will at least be tempered with a little mercy. It is not pleasant to discover that the ideal many desired so much and worked so hard to attain, has proved not merely a delusion, but also a snare.

Yours truly,

C. S. BEECHER, B.Sc.,
A.M.I.Mech.E., A.M.I.E.E.

Purfleet, December 22, 1924.

TO THE EDITOR OF ENGINEERING.

SIR,—With reference to the discussion which is at present taking place, may I remark that a point which, in my opinion, is not taken into consideration sufficiently is the change which has taken place in the distribution of the money available. In my year—1902—there were four scholarships and thirty exhibitions of 50*l.* each. To-day, I understand, there are eight scholarships and twenty-five prizes of 10*l.* each.

In 1902, I was nearing the end of my apprenticeship and looking forward to advancing on the practical side of engineering. The last thing I wished to obtain was a scholarship which necessitated my leaving the practical side of the work for three years. On the other hand, the 50*l.* exhibition, which I could hold whilst still at work, was a real attraction. Many young men of to-day must be in a similar position, and have offered to them a prize of 10*l.*, which does not go far towards the purchase of books or the paying of fees.

In my opinion, the effect of the change in the money distribution is that the few are assisted to become academics, whilst the many are practically neglected. This, I hold, is contrary to what was the wish of our benefactor—Sir Joseph Whitworth. In the circumstances it is not a matter for surprise that present-day engineering apprentices take so little interest in the scholarships and prizes.

Yours faithfully,

W. E. W. MILLINGTON, Wh.Ex.,
M.Inst.C.E., M.I.Mech.E.

54, Imperial Buildings, Oxford-road, Manchester.

"STANDARDS OF THERMAL EFFICIENCY."

TO THE EDITOR OF ENGINEERING.

SIR,—In your leading article on "Standards of Thermal Efficiency" (see ENGINEERING, December 19, page 835), you point out as a matter of interest that the phenomenon of supersaturation of steam was indicated as possible by Clerk Maxwell in 1880.

It is not generally known that the possibility of this phenomenon was first indicated by Professor James Thomson, the brother of Lord Kelvin, in 1871, in a paper read before the Royal Society (see Proceedings of the Royal Society, November 16, 1871).

Although in those days this supersaturation was not known, Professor Thomson thought that we need not despair of practically realising it in physical operations, which unfortunately is only too true, and he went on to suggest that the effect could be obtained by rapidly expanding initially dry steam in a cylinder with a moving piston; in which case the existence of supersaturation would be best ascertained by observations on its volume and pressure. This effect is, of course, now recognised as the explanation of the "missing quantity" shown by the indicator diagrams.

A reference to page 321 of his collected papers in physics and engineering (selected and arranged by his son and Sir Joseph Larmor and published in 1912 by the Cambridge University Press) will show that he conceived of the idea of supersaturation as early as 1862, though he did not publish anything on the subject till nine years later.

Yours faithfully,

WILLIAM THOMSON BOTTOMLEY, A.I.E.E.

25, Oaklands, Gosforth, Northumberland.
December 29, 1924.

BOILER TESTS.

TO THE EDITOR OF ENGINEERING.

SIR,—In view of the great attention at present being paid to the question of boiler efficiency, especially in its relation to powdered fuel versus mechanical stoking, the figures below may be of interest.

It will be observed that the test of which these figures are the result was taken quite recently, viz., on December 15, 1924, at our Neepsend Power Station. The boiler—a five-drum Stirling—is fitted with "Bennis" chain grates of the new type, having thin links in the centre and wide links on the outer edge. As will be seen, the efficiency (boiler, superheater and economiser) was 84·80 per cent. and having regard to the high initial and operating costs of powdered fuel equipment it seems to me extremely doubtful if any powdered fuel outfit is likely to yield better results. This is not an isolated test but one taken in the boiler house efficiency test, which is carried out weekly.

Sheffield Corporation Electric Supply Department: Chemical and Testing Laboratory.

No. 16 Boiler Trial Report, December 15, 1924.

Date of Test, December 11, 1924; Station, Neepsend; Coal Used Frickley Washed Slack.

Duration of test	5 hrs. 50 mins.
Heating surface of boiler	8,282 sq. ft.
" " of superheater	1,120 "
" " of economiser	4,100 "
Area of Bennis grates	182 "
Steam:	
Average boiler-gauge pressure	208 lb. per sq. in.
" " superheated steam	575 deg. F.
Water:	
Average temperature water leaving pump entering economiser	80 deg. F.
" " " boiler	127 deg. F.
Water evaporated per hour (actual)	211 deg. F.
" " per hour from and at 212 deg. F.	34,983 lb.
" " per sq. ft. of heating surface (B. & S.)	45,233 lb.
	4·81 lb.
Draughts:	
Ignition arch	0·22 in.
Combustion arch	0·3 in.
Over dampers	0·23 in.
Damper	0·74 in.
Gases:	
Temperature leaving boiler	579 deg. F.
" " economiser	281 deg. F.
" of boiler house	72 deg. F.
Average CO_2	10·8 per cent.
	L.H. R.H.
Speed of grates	4 3·8
Thickness of fire	5·4 5·4
Coal:	
Total coal burnt	24,990 lb.
" dry coal burnt	22,189 lb.
" ash and clinker, 6·71 per cent.	1,680 lb.
" combustible consumed	20,509 lb.
Coal (as fired), per hour	4.284 lb.
" " " per sq. ft. of grate	23·54 lb.
Heat units d/d. per sq. ft. of grate per hour	284,362 lb.
Water evaporated per lb. of coal (actual)	8·166 lb.
" " per lb. of coal from and at 212 deg. F.	10·558 lb.
Efficiency of boiler superheater and economiser	84·80 per cent.

Analysis of Coal Used and Boiler Ash.

Name.	Moisture.	Volatile Matter.	Fixed Carbon.	Ash.	B.Th.U. Wet.	B.Th.U. Dry.
Frickley Washed Slack	11·21	29·62	53·03	6·14	12,080	13,600
Refuse	0·00	1·00	7·50	91·50	—	1,286

Price of coal	18*s.* 3*d.*
Cost of evaporating 1,000 gals.—	
Excluding ash handling	7*s.* 8·6*d.*
Including ash handling	7*s.* 10·3*d.*

Heat Balance.

	Per cent.	B.Th.U.
Heat taken up by boiler	69·00	8,333
" " " superheater	6·95	840
" " " economiser	8·85	1,069
" lost as unburnt fuel in ash	0·71	86
" in dry chimney gases	6·77	818
" " in moisture and combustion of hydrogen	4·77	577
" lost by radiation (by difference)	2·95	357
	100·00	12,080

The rival manufacturers of mechanical stokers and powdered fuel plant are always ready to produce figures showing the most glowing results from their respective apparatus, but without in any way questioning their accuracy, I am of opinion that the independent figures of the engineers in charge of such plants are the important things to be studied.

The question is of very great importance, especially to station engineers: hence my reason for acquainting you with the results now obtained.

Yours faithfully,

S. E. FEDDEN, General Manager.

City of Sheffield Electric Supply Department.
December 23, 1924.

LABOUR NOTES.

JUDGING from articles in recent issues of *The Worker*, the National Minority Movement's prominent men are of the opinion that concentration on the engineering wages question represents good tactics from the point of view of the Red International Labour Union. The workers are, in effect, being told that their constitutional leaders are useless and lacking in the courage essential to leadership, and that if they ignore them, and take the course indicated by Communism, the employers will be forced immediately to concede the increase of wages demanded. The workers, collectively and individually, are, of course, perfectly free, if they choose, to leave a leadership which has been tested during many years of practical experience for one which has not. But before changing over they will be wise to take into serious consideration one very important fact. On the figures submitted by Sir Allan Smith at the first of the joint conferences attended by the representatives of the trade unions, the industry cannot bear any addition to its labour costs. No serious criticism of these statistical summaries has affected their significance in the slightest degree. They plainly indicate that an increase of wages will make profitable production impossible and increase unemployment.

So far—and this is a point which the workers should carefully note—none of the serious criticism of Sir Allan Smith's figures has come from the National Minority Movement's prominent men who have merely talked aimlessly about "watered capital" and so forth, and ignored the fact that the statistics related to turnover. Out of the balance left—it was 0·3 per cent. if our memory serves—after materials, labour and charges had been deducted—the profits on the invested capital were to be paid—as well as the increase of wages demanded by the men. No appreciable change has taken place in the industry's circumstances since Sir Allan made his statement. Foreign competition is, if anything, keener than it was, and prices have severely to be cut in order to get contracts. In view of these facts, the workers will, we imagine, have no difficulty in arriving at the conclusion that it will be to lay a course for widespread disaster to adopt the policy of the National Minority Movement. What the industry needs most at the moment is economic stability, and, in our opinion, nothing more clearly shows how that can be achieved than the statistics given by the chairman of the employers' Management Committee.

The demand of the shipyard unions, federated and unfederated, for increases of wages is equally as little justified by the state of trade. A great deal is being made by supporters of the applications of the fact that in 1924 the tonnage output of the yards was much greater than in the years immediately preceding. The output of shipyards expressed in gross tons is never a reliable measure of profitable activity, and, in this instance, the figures are positively misleading. No figures, similar to those submitted by Sir Allan Smith for the engineering industry, are available to prove this. In the Industrial Court's award of June last, however, Sir William Mackenzie said:—

"On 83 contracts on new work, not yet completed, it is estimated that, on the basis of the continuance of the present wages, there will be a loss of 785,000*l*. . . . It is not to be understood that these contracts were a speculation which turned out badly; they were undertaken, in many instances, with a view to keeping the industry alive."

As, in accordance with the award, wages were considerably increased, the loss on these contracts must have been much heavier. The larger tonnage output, which is being cited as a reason for advancing wages, might in reality be agreed to be a reason for reducing them. The shipbuilding industry is, as a matter of fact, in a very unsatisfactory state, and it cannot possibly stand any addition to its labour costs. New ship prices, which, by the way, may be easily ascertained by anybody who really desires to know them, are not only no better than they were, but show no sign of improving.

The Young Communist League is, as we mentioned some time ago, seeking a new field for its activities in the organisation of shipbuilding and engineering apprentices. One of the items in the programme for young metal workers is "No Piece Work." Piecework is described in an official publication of the organisation as:—

"A dangerous system for all workers, young or old. What has it meant to the young workers in the shipyards, *e.g.*, Leith, where we find that apprentices working on piecework, although they are paid at the same rates as the adult workers, are subjected to deductions of from 20 to 30 per cent. because they are apprentices? Piecework and other speed-up systems are merely a cloak behind which the young workers are subjected to a more brutal and ruthless exploitation. Its abolition must be strenuously fought for."

The framer of the propaganda from which we have extracted the foregoing can hardly be described as a diligent reader of Moscow's official literature, for an extensive use of piecework is one of the expedients adopted by the Soviet authorities for increasing the output of the workers in State factories.

According to a writer in the *Workers' Weekly*, 1,045 delegates were present at the recent Russian Trades Union Congress. Of these, two were under 19 years of age, 39 between 20 and 24 years, 272 between 25 and 29 years, 334 between 30 and 34 years, 275 between 35 and 39 years, 114 between 40 and 49 years, and 9 over 50 years. Eight hundred and twenty-six had received an elementary education, 187 a secondary school education, and 32 a high school training. Forty-eight of the delegates were women.

Mr. Brownlie, the president of the Amalgamated Engineering Union, alludes, in the course of a review of the past year in the organisation's "Monthly Journal," to the decline in membership. The society is being subjected, he says, to much adverse and unjustifiable criticism by erstwhile members. Every kind of reason, including the discontinuance of donations, benefit, etc., is being urged as an excuse for the non-recognition of their duty to their shopmates. It should be obvious, he points out, to the least reflecting individual that advances in wages and improved working conditions cannot be secured without the aid of an efficient trade union. Moreover, it should be remembered, Mr. Brownlie thinks, that since July, 1920, the union has expended nearly 6,000,000*l*. in benefits—a greater sum than any other British organisation of the same kind has spent in the same way in a like period. In his opinion that is unmistakable evidence of the stability of the A.E.U. and a sufficient guarantee that in the future, as in the past, the society will meet all its legitimate obligations to the membership if adequate support is obtained.

The Editor of the "A.E.U. Monthly Journal," who is, presumably, Mr. Smethurst, the general secretary, suggests that, unless the new powers of the General Council of the Trades Union Congress are used judiciously, there is a possibility of trouble ensuing with the unions involved. He is anxious, he goes on to say, to support a movement which has for its object the prevention of disputes between Unions. At the same time, he points out, the new powers given to the General Council make it possible for a union, although only slightly affected in a dispute, to call upon the General Council to intervene, and possibly to interfere with the policy of an executive responsible to a large body of members engaged in such dispute. It appears to Mr. Smethurst that before powers of so far-reaching effect (which make it possible for penalties to be imposed) are given to the General Council, affecting as they do the constitution of the unions affiliated to Congress, the membership should be called upon to cast their votes for and against such proposals.

In the course of an article on the National Wages Board, the *Railway Review*, the organ of the National Union of Railwaymen, says that in the machinery provided there is much that is commendable and the sooner it is empowered to cover all sections of the railway service, or alternatively, that some similar machinery for those outside is provided, the more satisfactory will become the method of negotiation as between the unions acting on behalf of all railway employees and the railway companies. There is certainly no reason, it is added, why this should not come about at an early date, if only those responsible from the employees' point of view will appreciate the fact that they should place first of all the interests of the workers themselves.

The Ministry of Labour states that on December 15, 1924, there were 1,158,500 unemployed persons on the registers of Unemployment Exchanges in Great Britain as compared with 1,182,188 on December 8 and 1,285,623 on December 31, 1923. Of the 1,158,500, 892,700 were men, 27,800 boys, 213,600 women and 24,400 girls. On December 8, the total was made up of 907,786 men, 29,444 boys, 218,917 women and 26,041 girls.

The Joint Council for the electricity supply industry in the North Western area has failed to agree on the wages question, and as a consequence the matter now goes before the National Joint Council. The unions asked for the restoration of the 10 per cent. reduction which took effect in 1923, and the bringing of the wages level up to the level of other areas. It was submitted by the representatives of the employers that the average cost of living figure to-day was the same as that on which the 1923 rates were based, and that an increase of wages could only be met by imposing extra charges on the consumer. A Special Tribunal reported in October against a national all-round increase, but left the area Councils free to reconsider wage rates. In the event of local differences there were to be references to the National Council.

A conference of Liverpool representatives of the Building and Allied Trades Employers' Association, the Building Trades Unions and the Technical Education Sub-Committee of the City Education Committee has arrived at an important decision on the subject of the training of apprentices. It has been arranged to give apprentices to the building trades a two years' course of training, and the scheme is to be carried on under an Advisory Committee composed of masters and men. The lads are to be released without loss of wages for one whole day in each week, and, in addition to the day classes, there will be illustrated lectures by experts in the evenings. After the two years' course of day classes, there will be more advanced evening classes for a further period of two years. Amongst the subjects studied will be new materials and methods in building and the use of machinery.

At a meeting on December 29, the General Council of the Trades Union Congress considered a letter from the secretary to the National Minority Movement containing an invitation to send delegates to a special conference which is being arranged for the purpose of promoting trade union unity. The council decided to instruct the secretary to call the attention of the Minority Movement to the reply which was sent to them during the proceedings of the T.U.C. at Hull. The purport of that reply was that the General Council would continue to act in accordance with the resolutions passed by the T.U.C. as sent in by the affiliated organisations and voted upon by the delegates appointed by the trade union representatives at the Congress. The secretary was instructed to reaffirm this policy, and also to inform the National Minority Movement that the T.U.C. General Council could not be represented at the proposed conference. In arriving at that decision, the General Council followed a strictly proper course, as it is, in effect, the executive committee of the Trades Union Congress and bound by its decisions. Until Congress formally permits the National Minority Movement to affiliate, the Council cannot recognise it; nor can any of the unions which are affiliated to it. The executive council of the Amalgamated Engineering Union is understood already to have acted in accordance with the Hull finding in the case of important District Committees which desired to associate themselves with the National Minority Movement.

An official report of the foregoing meeting of the General Council states that the Russian delegation "were not in a position to present to the council a full report of their investigations, but they amplified their report already published in the Press. Arrangements have been made to present to the Council a full report at the earliest possible date. It is hoped that the report will be out within a month. In the meantime, no further statement can be made."

THE INSTITUTE OF METALS.—The growing strength and importance of the Institute of Metals is illustrated by the list of members and students elected on December 29 last, which contained 68 names. Of these 32 were of persons resident abroad, of whom 21 were resident in the United States, illustrating the growing influence of the Institute overseas. The total membership is now 1,572.

OLD FERRANTIANS' REUNION.—There were nearly 50 old Ferranti men present at the third reunion, which was held at the Hotel Cecil, London, on December 17. The Chair was occupied by Mr. H. W. Knolle. Dr. S. Z. Ferranti was the guest of the evening. The occasion afforded an opportunity for renewing many old acquaintances and was much enjoyed by those present. The Chairman's speech formed something of a history and an appreciation of Dr. Ferranti's work, and Dr. Ferranti in reply added some reminiscences of his early days. Mr. C. L. Addenbrooke, who also spoke, added interesting details in connection with the Gaulard and Gibbs transformer.

BRITISH INDUSTRIES FAIR.—Several new features will combine to ensure a particularly attractive British Industries Fair when held during this year at Birmingham. Up till now it has been usual to hold a London section, the White City Fair, but this practice will not be followed during the current year. Instead, the two sections will be united, at Birmingham, mutual arrangements having been made by the Department of Overseas Trade and the Birmingham Chamber of Commerce, whereby identical groups would be organised for all trades that have hitherto exhibited in London. Further, the Lord Mayor of Birmingham and the City Corporation have decided to organise a Civic week during the Fair.

YEAR-BOOKS AND ANNUALS.

Letts' Engineers' Handbook and Diary.—This little volume, combining a diary with an engineering pocket-book, published at a price of 2*s.* net, is one of a series designed to be of use to specific classes of users. The technical information contained in that dealing with engineering is comprehensive and of real practical value to works managers, draughtsmen and students. Boiler efficiency, timber and rope data, screw-cutting, metal-tempering, weights of materials, all find a place in this useful little book.

Surveyors Tables and Diary, 1925.—A useful little book for surveyors, contractors, and others interested in the building trades has been sent to us by Messrs. Metchim and Son, of 8, Princes-street, Westminster, S.W.1. Though small enough for the pocket, it is probably intended for the desk as the binding would hardly be suitable for pocket use. It contains, in addition to the diary, about 60 pages of information and tables of use to builders, which have been revised and re-written by a fellow of the Surveyor's Institution. Included in the book is a summary of the London Building Acts, the names, addresses and areas of the District and Borough Surveyors of London, the fees payable for various services, and a large number of tables specially selected as useful to the builder and surveyor. The book is published by Messrs. Metchim and Son at the price of 2*s.* 6*d.*

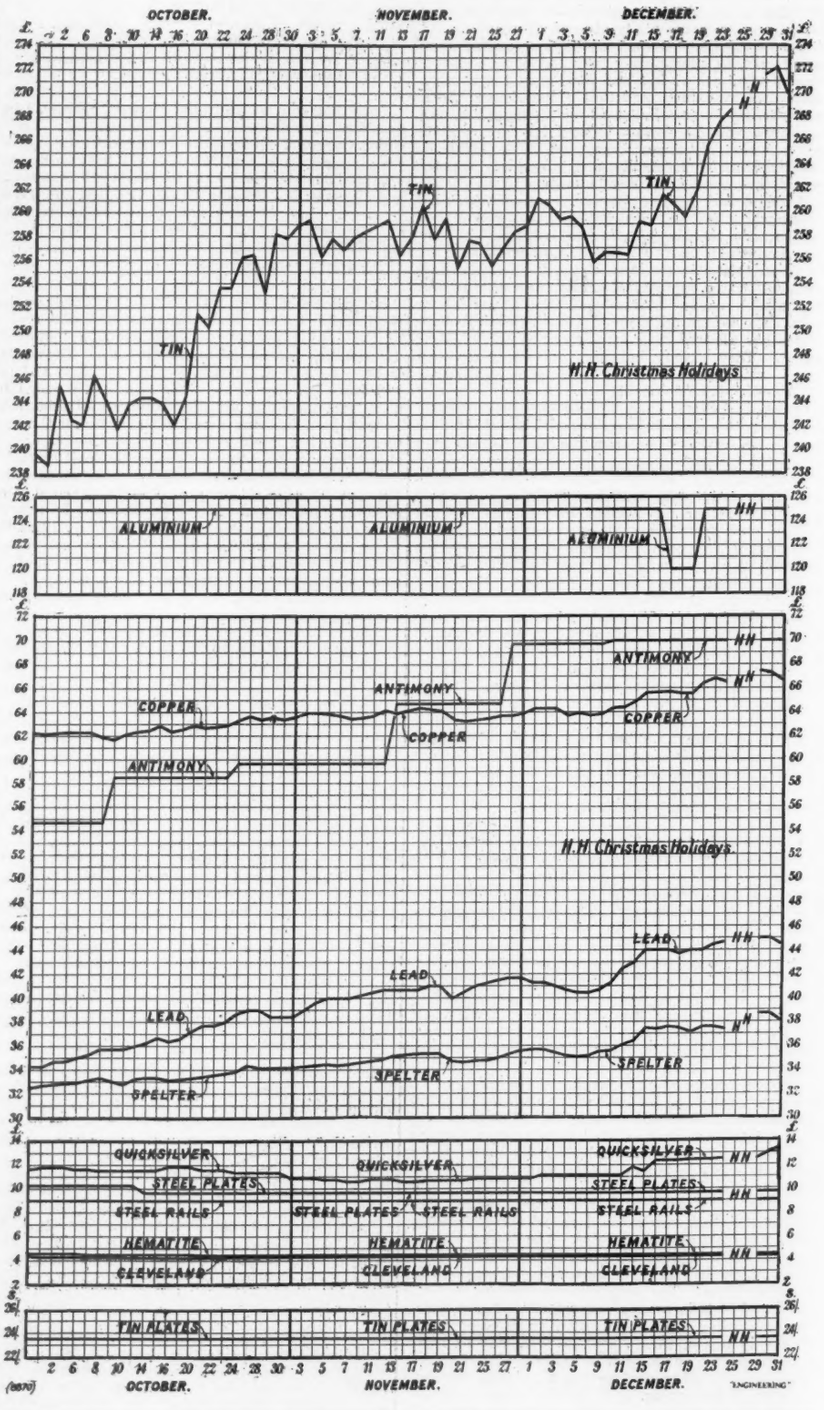
Laidlow's Practical Speed and Feed Guide and Diary for 1925.—Among the large number of diaries intended for workshop men which we have seen at one time and another, we do not remember anything which appeared more really "practical" than this useful publication. It is a sensible size, so that it can be carried in the pocket, and is yet not too small to enable the technical information and tables it contains to be printed in readable type. The tables give the class of information really required in a machine-shop, such as "Revolutions per Minute for various Cutting Speeds and Diameters"; "Screw-cutting Speeds and Feeds"; "Tapping Drill Sizes,"; "Gear-Milling Speeds and Feeds"; "Weights of Wooden Patterns and Metal Castings," &c. The book, which contains a diary for the year, arranged seven days on a page, is published at Braefoot, Crook of Devon, Kinrosshire, at 2*s.* net. It may be thoroughly recommended.

Almanacs and Calendars.—We have received monthly tear-off calendars from Messrs. Hulse and Company, Limited, machine tool makers, of Ordsal Works, Manchester; Messrs. Haslam and Stretton, engineers, Cardiff; The Wallsend Slipway and Engineering Company, Limited, engineers, boilermakers, ship repairers, and manufacturers of oil-burning installations; Messrs. Hollings and Guest, Limited, engineers, Thimble Mill-lane, Birmingham; Mr. Joseph Collard, manufacturing stationer and printer, 43, Charing Cross-road, W.C.2; The Birmingham Small Arms Company, Limited; Messrs. Wm. Clowes and Sons, Limited, Duke-street, S.E.1; The Beldam Packing and Rubber Company, Limited, 29, Gracechurch-street, E.C., Brentford, Paris, New York, &c.; Messrs. Aiton and Co., Limited, Derby; Messrs. Bruce Peebles and Company, Limited, engineers, Edinburgh; The Brown Hoisting Machinery Company, Limited, Cleveland, Ohio; The D. P. Battery Company, Limited, of Derbyshire. A series of calendar refills has come to us from The Welin Davit and Engineering Company, Limited, of Liverpool, Southampton, London, and Paris. Daily tear-off calendars have reached us from Messrs. Buck and Hickman, Limited, engineers, 2, 4 and 6, Whitechapel-road, E., ; Messrs. Newton, Chambers and Company, Limited, of Thorncliffe Iron Works, near Sheffield; Messrs. Vernon Proctor and Company, iron and steel merchants, 22, High-street, Sheffield; Messrs. Wm. Jessop and Sons, Limited, Brightside Works, Sheffield; the Associated British Machine Tool Makers, Limited, of 17, Grosvenor-gardens, London, S.W.1.

Diaries.—We have received from the Stanton Ironworks Company, Limited, of Stanton-by-Dale, near Nottingham, a handsome leather-bound note-book, containing a number of useful tables on pipe standard bends and sizes, constructional information, and a diary. A neat pocket-book and diary also was sent by Messrs. Braithwaite and Co., Limited, engineers, of 117, Victoria-street, London, S.W.1. This little book should be of great value to designers of steel frames on account of the useful data contained in it on the subject. The diary issued by Messrs. Hayward-Tylers, Ltd., manufacturers of pumping machinery, of Luton, contains notes and tables on pump sizes, efficiency, measurement of stream breadth and discharge, &c., together with postal and other general information.

DIAGRAMS OF THREE MONTHS' FLUCTUATIONS IN THE PRICES OF METALS.

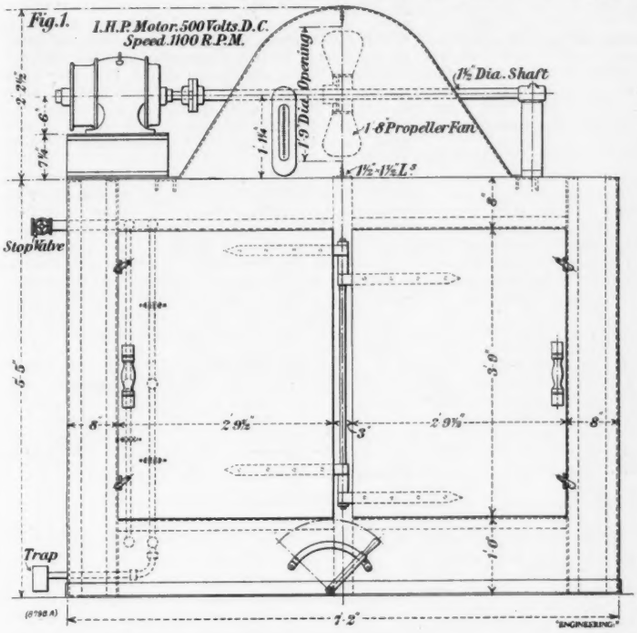
(Specially Compiled from Official Reports of London Metal Markets.)



NOTE.—In the diagrams the figures plotted for tin and copper are the official closing cash quotations of the London Metal Exchange for fine "foreign" and "standard" metal respectively. The prices shown for lead are for English metal, whilst those for spelter are for American metal. Middlesbrough prices are plotted for steel plates and rails, and also for hematite and Cleveland pig-iron. The prices given, in the case of steel plates are for ship, bridge and tank qualities, and those for steel rails are for heavy sections. The pig-iron prices are for East Coast hematite and Cleveland iron, both of No. 1 quality and for home consumption. The price of quicksilver is per bottle, the contents of which vary from 70 lb. to 80 lb. The price of tin-plates is per box of I.C. cokes f.o.b. at Welsh ports, but in other cases the prices are per ton. Each vertical line in the diagram represents a market-day, and the horizontal lines represent 1*l.* each, except in the case of the diagram relating to tin-plates, where they represent 1*s.* each.

THE "CIRPLEX" DRYING PLANT.

CONSTRUCTED BY MESSRS. TOMLINSON-HAAS, LIMITED, ENGINEERS, ROCHDALE.



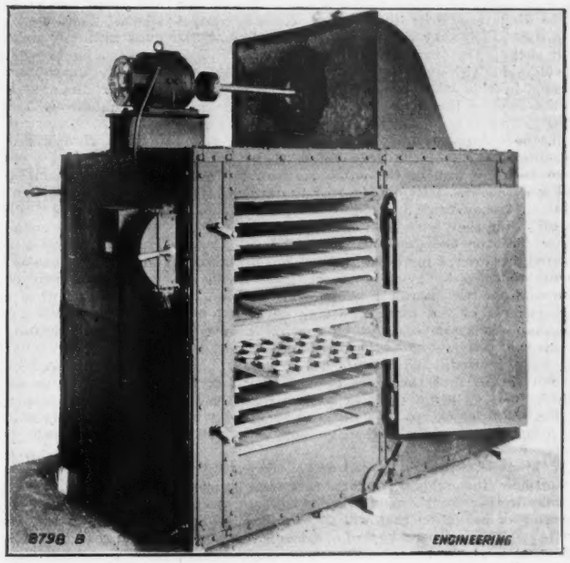


FIG. 2.

THE "CIRPLEX" DRYING PLANT.

IN many industrial processes at the conclusion of the workshop operations, the products are in a wet state and must be completely dried before they are suitable for marketing. In many cases the crudest and most inefficient plants have been used for the purpose, with a resulting expenditure which is quite unjustifiable. Of recent years, better methods have been adopted and attempts have been made to devise drying equipment for the purpose, which will give the desired results with little expenditure of time and money. As the work is of very varied character it will be appreciated that the plant which is best for one class of work may be completely unsuitable for others. An example of a drying plant for such processes as removing the moisture from colours, paste, salts and various other chemicals, vegetable matter and skins, is illustrated on this page. This is a product of Messrs. Tomlinson-Haas, Limited, of Soho Works, Rochdale, and has been given the trade name "Cirplex." It is of the type of plant in which the material to be dried is accommodated in trays, either plain or perforated, and air is circulated about the substance to remove the moisture, the whole being kept warm by means of steam pipes.

From the illustrations it will be seen that the drying chambers are built up of sheet steel, and these are enclosed in pairs within an outer steel case, the intervening space being used for the passage of air from the chambers out to the atmosphere. Above each pair of drying chambers there is an electric motor- or belt-driven fan situated within a casing. As may be seen in Fig. 2, where half the top casing is shown removed, the fan is mounted in a circular hole in a dividing plate. With this particular type of drying plant the air circulation may be varied at will, as the electric motor may be run in either direction, and suitable control apparatus is mounted on the side of the casing for the purpose. The air may be circulated continuously in a pair of drying chambers, down through the one and up through the other, or may be passed through the pair once and then discharged. The steam supply is passed into a series of horizontal pipes from a stop valve at the back, and its heat is taken up by the air; the condensate produced is drained off through an effective steam trap.

When the apparatus is used for drying vegetables, fruit, copra and all types of agricultural products, perforated trays are used, and the air is passed through the holes and the spaces between the particles of the substance under treatment. Should, however, the material that is worked with be a fluid or a chemical substance, plain trays without perforations are used and the air is passed over the top surface of whatever is in each one. To facilitate this action a gap is left at the side of the tray in the frame, through which the air may be passed from the space below. When the trays are placed in the chamber with these gaps alternately to each side the flow follows a tortuous path. If indiarubber, asbestos sheets or skins are to be treated, the trays may be removed and the articles suspended from above.

It will be appreciated that this plant is suited to the requirements of a large variety of drying work, and the air circulation and temperature may be controlled to the conditions under which efficient work is performed. As the temperature must be kept within suitable limits for the substances under treatment, a thermometer is accommodated in the top casing where it may be easily seen by the operator. For this drying equipment it is claimed that only 1¼ to 1¾ lb. of steam are required to liberate one pound of water from the substance to be dried, and in such a process as the drying of colours, usually a prolonged operation, only from 14 to 22 hours are necessary, depending upon the original condition and nature of the material.

THE HAZARDS OF PULVERISED FUEL SYSTEMS.*

By H. E. NEWELL and ROBERT PALM.

UNTIL recently the use of pulverised fuel has been practically confined to the cement and metallurgical industries. However, the satisfactory results given by this form of combustion in these industries have led to its adaptation to power-generating purposes. Indeed, the trend in this direction has been so pronounced that underwriting and fire-protection interests have deemed essential the preparation of suitable installation requirements.

Any material which is flammable will, when in the form of dust in suspension in the air, burn as a gas, provided the mixture of dust and air is one favourable to combustion; and the fact that the combustion of a pulverised fuel is similar to that of a gas alone makes the use of pulverised fuel possible. If, when properly mixed with air, the pulverised fuel will burn as a gas in the combustion chamber, it is obvious that, if liberated and permitted to be in suspension in the air in a room, ignition will result in a flash-fire. If the amount of fuel and air in proper proportion is large and the room is relatively small and without means for adequately venting the abnormal pressure incident to rapid combustion, the result will be a dust explosion. Further, it is well established that the more finely the material is divided, the greater the probability of spontaneous ignition.

These dangerous features make necessary correct installation requirements. As in the case of other types of combustion, safety from fire and accident will depend, first, upon design and construction; secondly, upon installation; and thirdly, upon operation and maintenance.

The principal installation features that minimise the fire hazard and go far toward safeguarding life as well are as set forth in the following paragraphs.

PRINCIPAL FEATURES UNDERLYING PROPER INSTALLATIONS.

Segregation.—Where practicable, the process of pulverising should be carried on in a separate detached building used for no other purpose, otherwise it should be carried on in a separate room or floor properly cut off from all other occupancies or processes. Unless located in the boiler-room, driers should be similarly segregated.

Construction.—The building containing pulverising equipment should be constructed of fire-resistive materials and specially designed, first, to secure a minimum lodgment of dust; secondly, so that all interior parts of the buildings on which dust may lodge may be readily cleaned; and thirdly, to relieve the force of an explosion through skylights, windows, or explosion doors. In some instances buildings have been erected with reinforced-concrete frames and with enclosing panel walls entirely of glass, a type similar to the well-known daylight form of construction. In other cases light construction has been the rule; or, in other words, a steel frame with cement-stuccoed walls attached thereto. Regardless of the type of construction, however, proper venting facilities for any explosion or abnormal pressure that may be exerted must be provided.

In order to prevent accumulations of dust, it is advisable so to plan the design of the building and so to shape structural members as to present the least possible extent of surface on which dust can lie. Construction must be such that no resistance will be built up in the path of an explosion.

Ventilation of Buildings and Apparatus.—It is important that all buildings or parts of buildings in which pulverising processes are carried on, as well as all apparatus, be well ventilated to the outer air. The avoidance of dust in suspension can only be secured by maintaining all apparatus in a thoroughly dust-tight condition.

Magnetic Separators.—It is apparent that if during pulverising a spark is created within the mill there will be a possibility of ignition, with a resultant explosion. This hazard, of course, varies according to the type of mill employed. In the case where air separation is employed, this hazard is probably somewhat greater. In order to reduce this hazard to a minimum, it is important that a magnetic separator be provided and installed ahead of the pulveriser. This separator should be of such size as to expose and assure the removal of scrap iron or any other

* Paper contributed by the A.S.M.E. Committee on Safety Codes and the American Society for Safety Engineers, presented at the Annual Meeting, New York, December 1 to 4, 1924, of the American Society of Mechanical Engineers.

magnetic substance that may find its way into the fuel.

Location and Arrangement of Driers.—Driers are of three types—the direct and semi-direct (both types being fired by a special drier furnace), and the indirect. The direct-fired type consists of a single shell, and the semi-direct of a shell within a shell. In the case of the direct-fired drier, the hot gases come in contact with the coal as they rise from the fire and enter the drier shell. This type is hazardous as there is a considerable risk of the fuel being ignited and passing in this state into the pulveriser feed bin. In the case of the semi-indirect-firer drier, the coal being located in the space between the outer and inner shell, the hot gases enter the inner shell and travel the entire length of the drier before they turn and come back by way of the space between the outer and inner shells. It is only during the return of the gases that they come in contact with the fuel, and by that time they have been considerably cooled. In either case the hot gases are by-passed to a stack. The indirect drier, a more recent development, involves drying the coal by means of inert gases which are secured from the flues or by superheated steam.

Regardless of the form of drying employed it is important that temperatures be controlled so as to avoid the possibility of the fuel within the drier becoming ignited. In general, driers should be of such a design that the gases of combustion of the heating unit shall not come in contact with the fuel within the drier except at a distance of at least half the length of the drier, and in no case within 18 ft. of the fuel bed.

If this type of drier is located within the pulverising department, it should be separated therefrom by means of a fire-resistive partition or provided with a protective covering or insulation that will withstand a one-hour fire test. As the general hazard of driers is comparable with that of a furnace, they may, as previously inferred, be located in the boiler room.

Bin Construction and Gauging Methods.—Pulverised fuel will flow practically as a liquid as the fine particles have no surface tension, thus making its confinement within a jointed container a very difficult matter and necessitating joints of great tightness. Great care in the construction of bins is, therefore, of primary importance. Failure to take proper care of this feature of bin construction will very likely cause trouble, as is indicated by the numerous small fires that have occurred due to leaky joints. It is also important that bins should be adequately vented so as to prevent the building up of any pressures within them. Such vents should extend as directly as possible to the outside air, and be arranged so as to prevent its entry into the bin.

Considerable difficulty has been experienced in designing a reliable method of gauging bin contents. To date there is none that the authors know of that will work efficiently in all types of systems. It is important, however, that some reliable means be provided to determine how much fuel is within the bin.

The absence of such means has in numerous cases resulted in serious injury to workmen who have endeavoured to obtain this information by opening a manhole cover in the bin and lowering an electric light on an extension cord within it.

Delivery to Furnaces or Other Points of Consumption.—Consideration should be given to the kind of piping installed, to the method of making joints, and to the provision of wearing plates at all points subject to abrasion. Piping should be so installed as to reduce to a minimum the effects of jarring and vibration, which might otherwise result in leakage at joints.

Electrical Equipment.—All electrical equipment for light and power in the pulveriser house should conform with the requirements of the National Electrical Code. Provisions should be made for remote control in order that current for light and power may be cut off in an emergency without entering the pulveriser house.

Housekeeping.—Good housekeeping is a factor of the utmost importance. To this end every portion in the pulverising plant should be kept free from even small accumulations of coal dust. All interior surfaces should be smooth and of a colour, preferably white, which contrasts with the dust. These surfaces should be cleaned at sufficiently frequent intervals to prevent accumulations of dust.

It is important that interior surfaces be cleaned in such a manner as to avoid the scattering or distribution of dust. This may be accomplished by employing an adequate vacuum-cleaning system. Compressed air may be safely used for blowing dust from motors or other similar inaccessible places, but it should not be used for blowing dust from walls or other interior surfaces unless in connection with a water spray.

TYPES OF SYSTEMS.

Pulverised fuel systems are of various types, but in general they may be arranged in three classes :—

Class A System.—Indirect, or those in which the fuel is intimately mixed with air at the point or points where used and involving storage bins at points of consumption.

From the standpoint of the fire hazard the good features of systems of this type include the strength and small size of fuel-delivery piping or other substantial ducts used to convey the fuel in a compact mass with only sufficient air in the piping to keep the mass in a liquid condition, and the practical elimination of danger of rupture of the piping or ducts. These features eliminate the explosion hazard and danger of spontaneous ignition within the transportation system.

Class B Systems.—Direct, or those in which the pulverised fuel is fed to a fan by which it is blown as a combustible mixture through large pipes to furnaces or other points of combustion. In the case of circulating systems of this class, the unused fuel is returned to the initial point to be again blown through the line. A variation of this type of system employs bins as sub-stations from which the furnaces are fed ; this arrangement has the tendency to minimise the inherent hazard of this system.

There are certain undesirable features of such systems which may be stated as follows. Lightness of pipe construction ; large size of pipes employed, which increases the volumetric capacity of the system ; and the fact that fuel and air within the piping constitute a more or less explosive mixture. There is also a distinct liability of the interior of the pipes to silt up, with a consequent probability of spontaneous ignition within the piping system. Experience has also indicated that there is a possibility of the primary fans ceasing to operate while the secondary fans continue in operation.

Unit System.—Those in which the fuel is pulverised at or near the point or points of use and delivered directly from the pulveriser into the furnace by means of a fan or blower—which may be an integral part of the apparatus, the air being admitted in the apparatus or in conjunction with the fuel. Bins are not employed. In systems of this type it is highly probable that the fuel will not be pulverised to the same degree of fineness as in the case of other systems. From the fire-hazard standpoint this is a good feature for the reason that greater resistance is offered to ignition. A feature of value is the relatively small amount of pipe and consequent reduction of volumetric capacity of the system. If long runs of pipes or ducts are used, the value of these safety features is largely offset and the general hazard materially increased. These systems do not usually employ driers.

DRIERS OF THE INDIRECT TYPE.

Driers of this type have previously been briefly mentioned. As a general rule, they are located in the boiler-room and employ inert flue gases or superheated steam as a drying agent.

The principal source of danger is that due to the possibility of spontaneous ignition of coal lodging on the interior. Such driers should be provided with substantial, easily operated shut-off valves between the raw-coal bunker and the drier ; similar valves should be placed between the drier outlet and the mill. It is especially important that an indicating alarm device be installed in the driers so as to permit ready determination of drier temperatures. All these constitute effective safety devices. In addition to the foregoing, means should also be provided to divert the contents of the drier to the outside in an emergency.

SAFETY REQUIREMENTS.

In order to permit ready evacuation of buildings, a sufficient number of exits must be provided which are in accordance with standard requirements. Such exits should, of course, be properly indicated.

Standard preventive measures in structural and mechanical details must be provided throughout. Where flue gases are used in connection with these systems, care must be exercised to prevent their escape into any of the rooms or departments. Provision should also be made for their removal from any of the bins. These precautions are necessary owing to the toxic effect of these gases upon the employees. The only way to effectively guard against this danger is by means of a comprehensive ventilating system, either natural or mechanical. Remote emergency-stop control for all apparatus should be provided.

Provisions should be made at the motor to prevent starting by any person other than the one charged with its examination, operation, or repair ; this can be accomplished by means of a locked safety switch.

Fire Protection.—The importance of having at hand ready means for the extinction of fires at their commencement is apparent. These means should be in the form of first-aid appliances, so that application by one man will be possible. To this end it is urged that small hose be provided on inside stand-pipes, supplemented by an adequate supply of approved chemical extinguishers, including those of the carbon-tetrachloride type for use in connection with possible electrical fire. This equipment should be systematically located so that no undue delay will occur in an emergency ; probably this can best be accomplished by locating such equipment immediately outside of and at the entrance to the pulverising department in the case of buildings with other occupancy, and inside at entrances in the case of separate pulveriser buildings.

As a means of extinguishing fires that may occur within driers of the indirect type—that is, those employing flue gases or superheated steam—provision should be made for introducing live steam or inert gases controlled by means of quick-acting, accessible valves.

It must be borne in mind that fires in locations where combustible dusts are likely to be present create the possibility, and indeed probability, of dust explosions. It is obvious, therefore, that means for prompt notification in case of fire be available—a requirement that can be met by a properly designed and installed manually operated fire-alarm system. As this requirement also involves watchman's service, the system can very properly, be of the combined fire-alarm and watch type. Boxes should be placed in the vicinity of entrances.

With the foregoing features relating to safety requirements and fire protection properly safeguarded, there remain only the important factors of operation and maintenance to be taken care of. If pulverised-fuel systems are safeguarded along the line described and competently operated and maintained, the life and fire hazards will be slight.

THE POLAR TWO-CYCLE HEAVY OIL ENGINE.

FOR many years the designers of heavy oil engines have endeavoured to obtain a combination of the high thermal efficiency of the Diesel engine with the simplicity of construction and operation of the hot bulb engine. An example of work along these lines is to be found in the design of the two-cycle Polar heavy oil engine, which operates with airless injection. This engine, which is made in Stockholm, is placed on the market in this country by the Atlas Diesel Company, Limited, of 35, Surrey-street, Strand, London. Illustrations showing the design of the components are given in Figs. 1 to 6, on the opposite page.

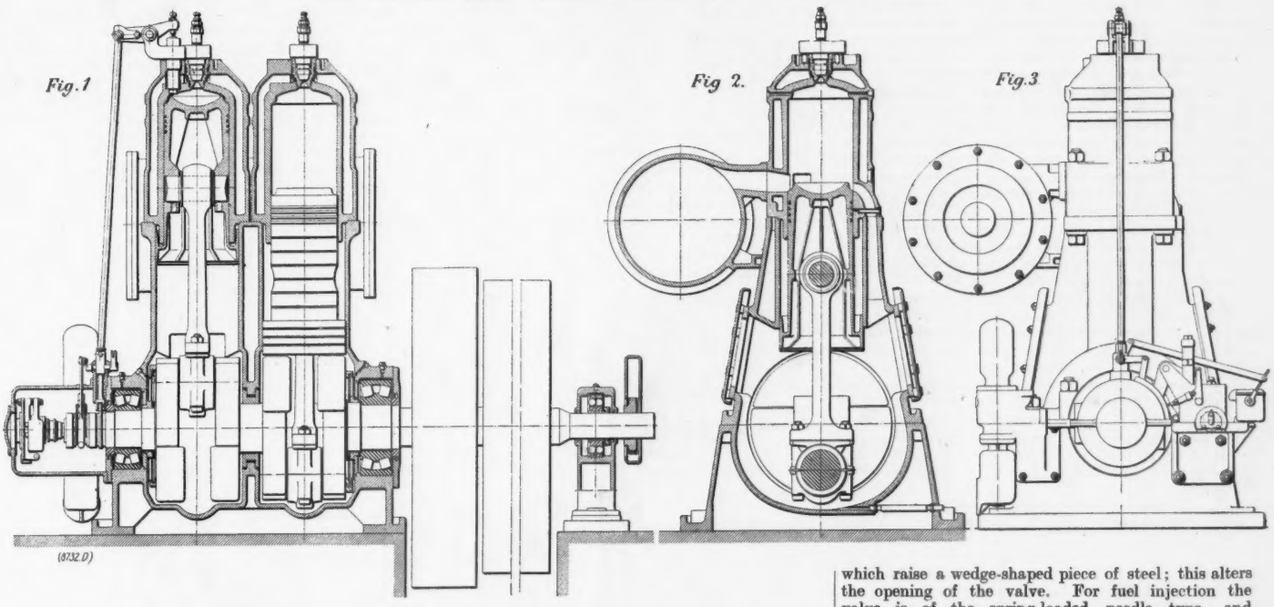
The Polar engine in question, known by its manufacturers as type H, is a 70 brake horse-power engine of the vertical, single-acting two-cycle type, in which the crankcase compression is used for scavenging. It is a true Diesel engine, and makes use of pump injection rather than atomising by the assistance of compressed air. As the cooling effect caused by the introduction of atomising air is avoided in this engine, it is possible to use compression pressures slightly lower than those commonly employed with the ordinary air injection engines. The piston is of the stepped type to facilitate the scavenging action. The air for this purpose is drawn into the crankcase through disc valves in the covers over the inspection holes.

The constructional features of the engine are of interest. A single casting serves for the bedplate and the lower half of the crankcase (see Figs. 1 and 2), and gives support to the main bearings. These are of the self-aligning roller type. The frame to which the cylinders are bolted is of cast iron and is provided with very large inspection openings. It is in these that the inlet air valves are accommodated. A forging of Siemens-Martin open-hearth steel constitutes the crankshaft, on the crank arms of which counterbalance weights are provided, converting the cranks into discs. This is clearly indicated in the two cross-sections of the engine, Figs. 1 and 2, and also in Fig. 6, which shows the shaft itself. The cylinder, its cover and the water-jacket are cast in one piece so that no trouble can be experienced with packings and gaskets. Several hand holes in the water-jacket wall serve for cleaning and inspection. For holding the cylinders in place on the engine frames, four heavy bolts are used. The piston is of the stepped type, as has already been mentioned, and its construction is not only shown in the cross-sections, Figs. 1 and 2, but also by the view given in Fig. 5. The large diameter part runs in the cylindrical guides formed by the inside of the frame, and serves as the scavenging piston. Both the piston and the under face of the cylinder head are cupped to obtain a clearance space of suitable form for effective combustion. Near the top of the piston, four expanding cast-iron rings are fitted. The connecting rod is a simple forging of open-hearth steel.

One of the most important accessories of the engine is the fuel pump. As very high pressures must be obtained by its action, the components are machined and ground with great care and precision. In this pump, the plunger is actuated on its working stroke by a cam and is returned by the action of

THE POLAR TWO-CYCLE HEAVY OIL ENGINE WITH AIRLESS INJECTION.

THE ATLAS DIESEL COMPANY, LIMITED, ENGINEERS, LONDON.



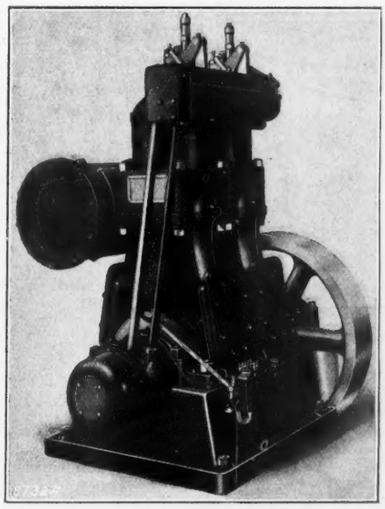


FIG. 4. ENGINE WITH FUEL PUMPS ABOVE THE CYLINDERS.

FIG. 5. PISTON, GUDGEON PIN AND RINGS.

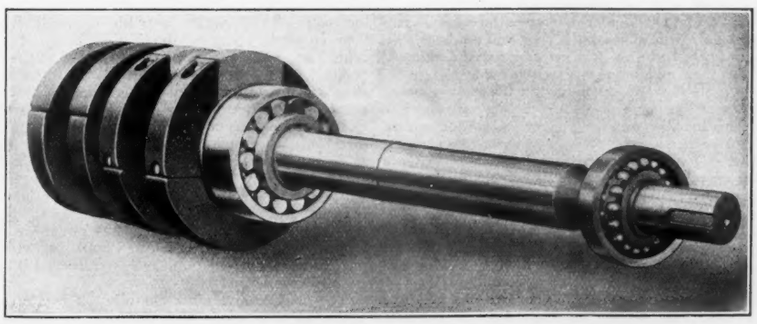


FIG. 6. CRANK SHAFT WITH COUNTERWEIGHTED CRANKS.

a spring. For the suction valve, which is of the usual type, a lifting device is provided by means of which the pump may be thrown out of action. There is a regulating valve of the by-pass or return type. It is opened at the end of the pressure stroke of the pump, and the fuel oil remaining in the barrel flows back into the suction chamber. The movement of the regulating valve is obtained from the governor through levers which raise a wedge-shaped piece of steel; this alters the opening of the valve. For fuel injection the valve is of the spring-loaded needle type, and the arrangements are such that adjustments of the spring may be made while the engine is running. As a single-hole type of sprayer is in use in this fuel system, the hole may be comparatively large, with the consequent advantage that there is little chance of it being choked up. On the front of the bedplate there is a circulating pump for the cooling water; this is worked by a connecting rod from the main shaft. All the components of this pump are made of bronze. The lubrication of crank pins, cylinders and the other important parts is obtained from separate pumps with a common operating system. The oil from the various units is carried through sight feeds, and adjustments of flow are possible. Starting is performed by the use of compressed air from a storage reservoir, a small air-compressor being driven by the engine for the purpose of obtaining supplies at a suitable pressure. This compressor is provided with a clutch, so that it may be put into and out of action at will.

The cylinder dimensions of this engine are 250 mm. bore and 350 mm., stroke and the engine runs at 300 r.p.m. The guaranteed fuel consumption of the engine at full load is 0·41 lb. per brake horse-power-hour, while 0·003 lb. of lubricating oil is used per brake horse-power-hour. Similar single cylinder engines of 35-h.p., as well as one and two-cylinder sets, giving 50-h.p. per cylinder, are also standardised products of the Atlas Diesel Company, Limited.

INDIAN SHIPPING RETURNS FOR OCTOBER.—The tonnage of vessels entering British India ports and cleared outwards, with cargoes from and to foreign countries and British possessions, during the month of October, 1924, amounted, respectively, to 652,000 and 700,000, as against 510,000 and 644,000 during the preceding month and 581,000 and 610,000 in October, 1923.

THE ITALIAN NAVAL PROGRAMME.—Soon after the autumn manœuvres were over, the Italian Government increased its naval building programme by ordering eight destroyers, six submarines and six minelayers. Very few details about the specifications of these new units have as yet been published. The destroyers will probably be of about 1,500 tons, and the submarines about 800. It has not been stated whether or not this additional construction is connected with the lessons taught by the recent manœuvres.

THE WHITWORTH SOCIETY.—The second annual Commemoration Dinner of this Society was held at the Holborn Restaurant, London, on December 20, and proved a great success. Mr. R. B. Buckley, C.S.I. (the senior Whitworth Scholar, 1869) presided, and was supported by about 80 members. This year's Whitworth scholars were invited as guests, and six of them had accepted. The President announced that the Committee had elected Mr. Wm. Sisson, of Gloucester, Wh.Sch., 1874, as succeeding President. It is hoped that Members will complete their "Who's Who" forms at once, and send them in to the Hon. Secretary, c/o Institute of Mechanical Engineers, Storey's Gate, Westminster, S.W.1.

DIE CASTING.*

BY NORRIS CLEMENTS BARNARD, Worcester, Mass.

DIE casting, according to the modern conception, is the art of forcing molten metal under pressure into a mould or die that remains intact for operations after the casting has been removed. The elements necessary to produce successful die castings may be considered from three points: machine, alloys, and dies.

The machine used must be capable of mounting the die and handling the metal used in the castings. These functions must be uninterrupted. The metal employed must be one that will melt successfully in iron receptacles and produce sound and enduring castings. The construction of the die must be such that it will permit the formation of the casting as designed. The proper execution of these three requirements assures the production of successful castings.

In order to add special local qualities to certain parts of otherwise successful castings, pieces of material possessing these properties are cast into the object, forming an integral part of it. The use of these inserts broadens the field of die casting immensely.

In the following the author will treat briefly each of the elements suggested above: namely, casting machines, alloys, dies, castings, and inserts.

Die-Casting Machines.—The first casting machines manufactured type and bullets. The early demand for large quantities of type stimulated the development of such machines a quarter of a century before they came into use for general casting purposes. Type casting is in reality a specialised branch of the die-casting industry.

Fig. 1 shows a type-casting machine patented in 1849. This machine, which is of the plunger type,

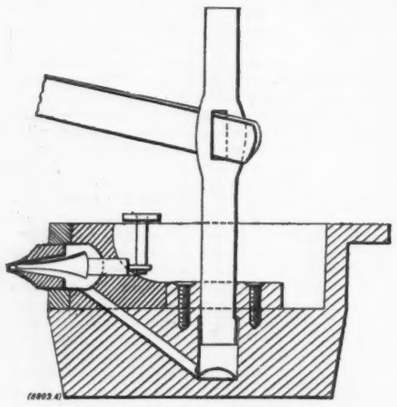


Fig. 1. TYPE-CASTING MACHINE OF 1849

pumps metal into the mould, and is very simple but very effective. The first die castings were produced on machines of this type, which had in addition to the equipment shown in Fig. 1, a means of mounting and operating the dies.

Some of the machines that are in daily operation at the present time embody the same principle. Fig. 2 gives a cross section through a modern casting machine of this type. A comparison of Figs. 1 and 2 will show that the two machines are essentially alike, both having the same pumping action to move the metal.

This machine injects the metal into the die between its halves. This constitutes a very simple and direct method of introducing it. The pressure on the molten metal must remain until the metal in the die partly solidifies, so that it will not flow back into the casting chamber on the removal of the pressure.

Fig. 3 shows a section of another machine of this type. In this case the metal passes up from the casting cylinder *b* through the water-cooled gate former 1 into the die 2. As soon as the metal comes to rest after its rush into the die, this cool gate former solidifies it so that it will not flow back into the casting cylinder. This rapid cooling permits the die to operate at a very fast rate, which means lower production costs. The die frame of this machine tilts from a vertical position to that shown in the figure, to remove the gate former from the casting chamber. In the great majority of cases the white-metal dies used on these plunger machines are rather small and light. For this reason the tilting of the die frame does not constitute a serious objection. However, if a simpler motion were substituted, the machine would operate faster and more easily.

The plunger-type machines as illustrated are very effective when using metals having low fusing temperatures, such as lead, tin, and zinc alloys. In the early stages of the industry only lead and tin were employed as in type casting. A short time afterwards zinc alloys came into use, and later aluminium found its way into the art.

The plunger machines, however, could not successfully handle aluminium with its higher melting point. The metal solidified between the plunger and the cylinder, causing them to stick together. This necessitated the repeated cleaning of these parts, so that casting costs rose to a prohibitive figure.

To eliminate such troubles overhead machines came into use. As Fig. 4 illustrates, in these the melting pot and its accessories stand above the die. In the machine shown at (*a*) a plunger *m* rises above the inlet *g*, permitting the metal to flow down into the die cavity. When the die fills, the downward motion of the plunger cuts off the flow of the metal at the inlet, and at the same time increases the pressure within the die.

In another construction, shown at (*b*), the valve *g*

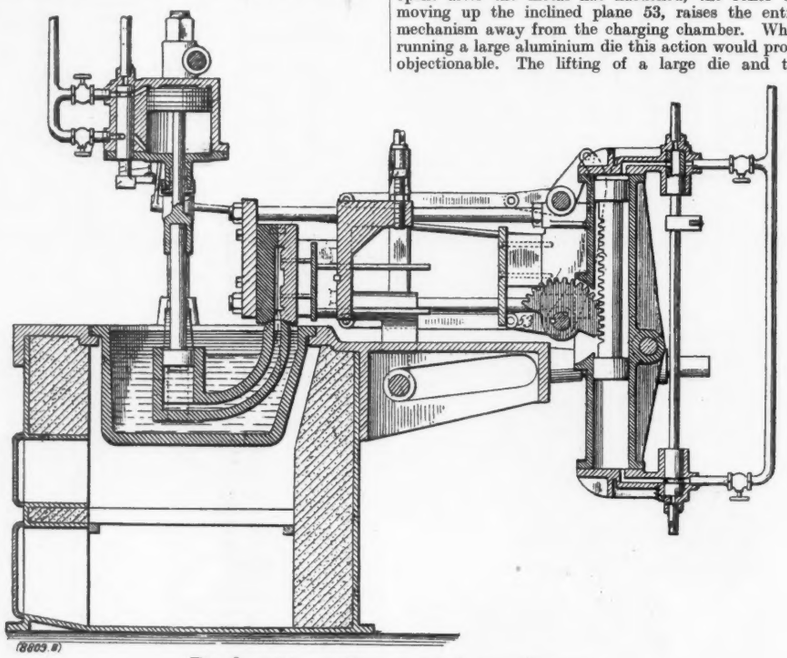


Fig. 2. A MODERN PLUNGER DIE-CASTING MACHINE

permits the metal to flow into the die by gravity. Air pressure entering through the pipe *i* after the valve *g* closes, creates the pressure that properly fills the mould.

This type of machine relies upon the direct application of air pressure to the molten metal to obtain a sharply defined casting. Early writers on the subject condemned the use of air in this connection because of its great affinity for liquid metal. However, other troubles developed which proved to be more objectionable. The valve *g* and the plunger *m* of these machines became stuck just as the old plungers did, when using metals of high melting points. Also, it was necessary to lift all fresh charges of metal into the high melting pot. If the valve or the pot became defective, the entire charge of metal flowed down upon the floor and now and then upon an operator in his position under the machine.

In order to eliminate the troubles inherent in all moving parts that are submerged in the molten metal, machines of the type illustrated in Fig. 5 came into use. This machine has no plunger, valves, or equivalent moving parts. Air pressure entering the charging chamber 3 forces the metal into the die. After a casting operation, the charging chamber dips into the melting pot 2 to obtain a fresh charge of metal through its nozzle.

Early predictions that this type of machine would never prove satisfactory, due to the oxidising action of the air upon the molten metal, have not been substantiated. The absence of parts rubbing together while submerged in the metal has ensured its popularity. The plunger, as used in the older type of machine, exerts more pressure upon the metal, but air proves more practical for metals with high melting points. This machine is of the same general design as the plunger machine of Fig. 2. The good and the bad features are largely common to both. Dies mounted on these machines may have cores that pull in five directions: to the right, to three sides of the die—upward, away from the observer, and towards the observer—and short pulls to the left. Due to the close proximity of the melting pot no cores may extend downwards. This places a limitation on dies for complicated castings or multiple-impression dies.

In the first firing of these machines the dies, in their position directly over the melting pot and furnace, heat as the metal melts. This is an advantage, in that a warm die produces better castings than a very cold one. The metal will flow more readily, permitting the die to fill more evenly. On the other hand, the work of operating a die-casting machine is very hot at best. In a case such as this, where the operator must work right over the molten metal, the job will prove to be an exceedingly warm one. These two machines offer a very direct path through which the metal flows while entering the die cavity. This direct flow tends toward sharply defined castings. The pressure used to force the metal and the inertia of the latter serve to throw it into the remote portions of the impression, resulting in clean-cut castings. Each time the die opens after the metal has hardened, the roller 52, moving up the inclined plane 53, raises the entire mechanism away from the charging chamber. While running a large aluminium die this action would prove objectionable. The lifting of a large die and the mechanism required to mount and operate it require a large amount of power.

Fig. 6 shows another air machine of this type. Here the metal enters the die through one of its halves, in a manner similar to that employed in sand moulds. In this respect the machine resembles the plunger type shown in Fig. 3.

This construction makes it necessary for the metal, on reaching the parting line between the die halves, to flow round an angle of 90 deg. before entering the casting cavity. This bend naturally absorbs some of the beneficial force of the flow. In this respect the air machine of Fig. 5 is better. Due to the dies being located beside rather than over the furnace, they do not heat so rapidly during the initial firing. The heat taken out of the first few castings remedies this shortcoming. The operators work beside the furnace rather than over it. Consequently this machine holds more attraction for the operator than the previous one.

As the illustration shows, cores may pull in all six directions, as some castings require. If only five sides are available for cores, as is the case in Fig. 5, the holes or cavities on one side of the object cannot be cast. The subsequent machining of these parts increases the cost of the product. Unlike the previous machine, the die while opening does not move diagonally upward, but moves back in a horizontal line. The weight of the die remains at one level, so that it requires no power to lift it.

The heavier and more complicated half of the die is the one that moves back and forth to open and close it. From a mechanical standpoint it would be more efficient if the lighter portion moved rather than the heavier, and in some instances there is a great difference in weight. If it were possible to make this change and introduce the metal as effectively as at present, the resulting combination would undoubtedly prove more satisfactory. Moving parts of reduced

* Abstract of paper submitted to the American Society of Mechanical Engineers, 1924.

weight would require less power for their operation. In later machines an air cylinder has replaced the rack and pinion for opening and closing the die.

Fig. 7 is a more detailed view of the gooseneck or charging chamber of the machine shown in Fig. 6. This cross-section shows it in the casting position, while the dotted lines represent the recharging position.

Die-Casting Alloys.—In the days when type casting monopolised the entire die-casting field, the alloy best adapted to this use was one composed largely of lead. The same holds true to-day.

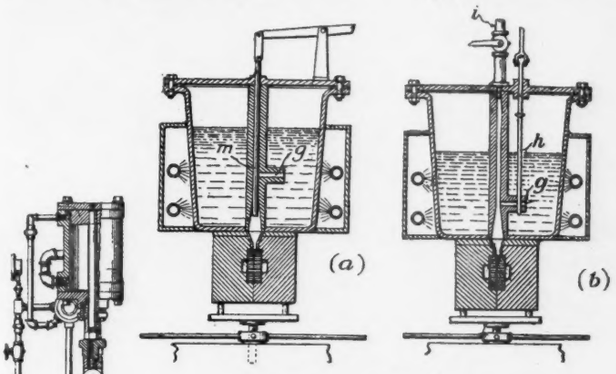


Fig. 4. OVERHEAD MACHINES

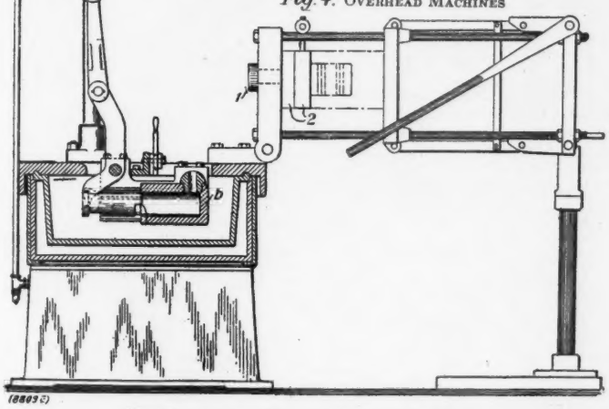


Fig. 3. ANOTHER MODERN PLUNGER MACHINE

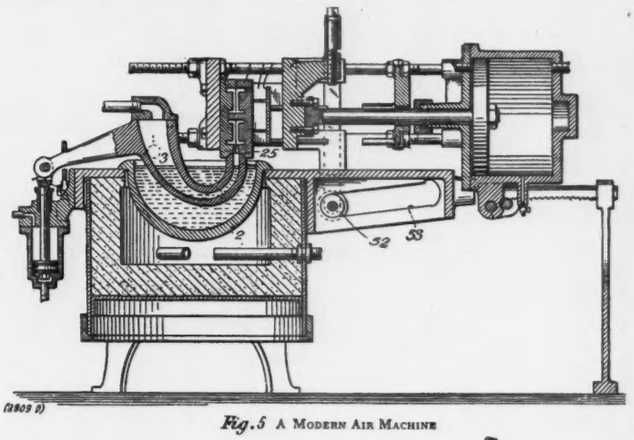


Fig. 5 A MODERN AIR MACHINE

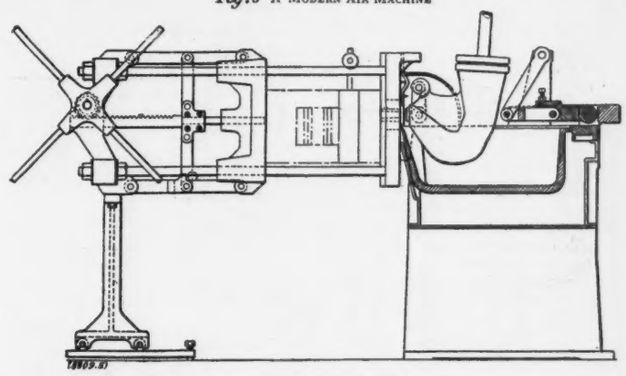


Fig. 6. ANOTHER MODERN AIR MACHINE

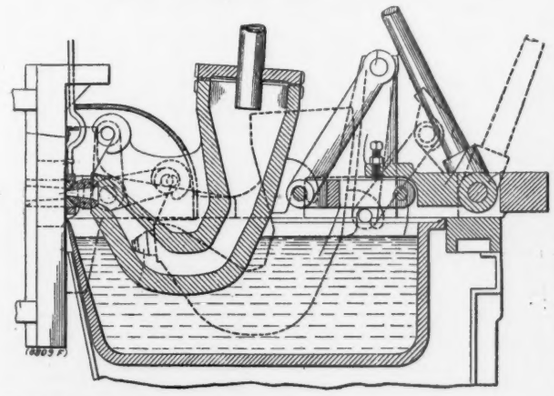


Fig. 7. ENLARGED VIEW OF GOOSENECK OR CHARGING CHAMBER OF MACHINE SHOWN IN *Fig. 6*.

When the industry broadened to include general castings these same lead alloys were used in the first products. With, however, a very soft composition and a low tensile strength, castings of these alloys could supply but a very limited field. The addition of tin slightly improved the qualities of the castings, but the increase of strength obtained was not sufficient to permit the development of die casting to any great extent. Zinc alloys offered the first opportunity to obtain castings of fair strength, which could compete with cast iron. Since then aluminium with its strength and lightness has met with great popularity. The demands of the automobile industry have stimulated the development of alloys of this metal, and to-day castings from them compose the major output of the die-casting industry. Because of the beneficial effect of the rapid chilling of an aluminium alloy in a die, these castings excel those made in sand moulds.

In the beginning of the industry the men that associated themselves with it knew very little about the principles of metallurgy. While they were confining their whole attention to lead and tin their ignorance was no serious drawback, but when they started to employ zinc in order to obtain additional strength, they encountered some serious difficulties. Their hit-or-miss methods in the alloying of metals proved very disastrous in some cases. The castings produced were satisfactory in appearance and equally so in regard to strength. However, after a period of service their bright metallic luster turned to a dull grey hue. The castings increased slightly in size, warped, and in some cases developed large cracks and even fell apart. General atmospheric conditions controlled this deterioration to a marked degree. Heat and moisture, such as from steam, greatly stimulated this action. These results gave die castings a very bad reputation. Engineers and the buying public associated this deterioration with all die castings.

A careful study of conditions has thrown a great deal of light upon these reactions. Even to-day the exposure to moisture of the zinc alloys in general use will quickly cause corrosion. Consequently, under such conditions some non-corrosive substance should protect them.

Below are given the compositions, properties, casting limitations, and applications of four alloys—one from each of the basic groups, lead, tin, zinc, and aluminium. The metal content can vary to alter the properties, but the alloys given are representative of the various groups.

LEAD-BASE ALLOY.

Composition (approximate):	
Lead	83 per cent.
Antimony	17 per cent.
Casting Limitations:	
Maximum weight of casting	25 lb.
Minimum wall thickness	$\frac{1}{32}$ in.
Variation in size of castings per linear inch	± 0·001 in.
Threads:	
External (maximum number per inch)	34
Internal	Sometimes cast.
Minimum Size of Holes (Depends on length of hole and size of casting).	$\frac{1}{32}$ in.
Draw:	
Cores (per inch of length and diameter)	0·0005 in.
Side walls (per inch)	0·001 in.
Physical Properties:	
Colour	Grey.
Specific gravity	10·03.
Weight per cubic inch	0·382 lb.
Melting point	600 deg. F.
Chemical Properties:	
Reactions:	
Atmosphere	Slight oxidation.
Hydrochloric acid	Slowly soluble.
Sulphuric acid	Not soluble.
Nitric acid	Readily soluble.
Organic acids	Form poisonous lead salts.

As this alloy reacts but slowly with the atmosphere it can be polished. It nickel-plates to good advantage.

Application:

This alloy is a typical type metal. It is also one of the finest bearing metals known where the speed and pressure are moderate. It may be used in parts where non-corrosion is a necessity. Due to its reaction with organic acids it is unsuited for food containers.

TIN-BASE ALLOY.

Composition (approximate):	
Tin	86 per cent.
Copper	6 per cent.
Antimony	8 per cent.
Casting Limitations:	
Maximum weight of casting	20 lb.
Minimum wall thickness	$\frac{1}{32}$ in.
Variation in size of castings per linear inch	±0·0005 in.

Threads :	
External (maximum number per inch)	34
Internal	Sometimes cast.
Minimum Size of Holes (Depends on length of hole and size of casting).	$\frac{1}{32}$ in.
Draw :	
Cores (per inch of length and diameter)	0·0005 in.
Side walls (per inch)	0·001 in.
Physical Properties :	
Colour	Silver white.
Specific gravity	7·4.
Weight per cubic inch	0·266 lb.
Melting point	450 deg. F.
Initial fusing point	425 deg. F.
Chemical Properties :	
Reactions :	
Atmosphere (under normal conditions)	No reaction.
Mineral acids	Slow reaction.
Alkalis	Slow reaction.
Organic acids	No reaction.

Due to its lack of action with the elements this alloy will maintain a polish. It plates readily by the usual commercial processes.

Application :

The chief uses for this alloy are in high-class bearings for engines and machine parts requiring a low tensile strength but high resistance to corrosion.

Zinc-Base Alloy.

Composition (approximate) :	
Zinc	88 per cent.
Tin	8 per cent.
Copper	4 per cent.
Casting Limitations :	
Maximum weight of casting	20 lb.
Minimum wall thickness :	
Small castings	$\frac{1}{16}$ in.
Large castings	$\frac{1}{8}$ in.
Variation in size of castings per linear inch	= 0·001 in.
Threads :	
External (maximum number per inch)	30.
Internal	Sometimes cast.
Minimum Size of Holes : (Depends on length of hole and size of casting).	$\frac{1}{32}$ in.
Draw :	
Cores (per inch of length and diameter)	0·001 in.
Side walls (per inch)	0·001 in.
Physical Properties :	
Colour	Silver white.
Specific gravity	7·20
Weight per cubic inch	0·253 lb.
Melting point	780 deg. F.
Initial fusing point	275 deg. F.
Tensile strength	16,000 lb. per square inch.
Elongation	2 per cent.
Compressive strength	27,500 lb. per square inch.
Hardness (Brinell)	64·6.
Chemical Properties :	
Reactions :	
Moist atmospheric conditions cause	Corrosion.
Mineral acids	Soluble.
Alkalis	Soluble.

As this alloy may be readily plated with the common plating materials, such as nickel, copper, brass, silver, or gold, these substances may be used to protect it from corrosion. It may also be soldered readily.

Application :

This alloy deteriorates owing to slight crystalline growth. It will not stand sudden shocks or severe strains. A few of its uses are for castings of phonograph parts, magneto frames, calculating machines, automobile accessories, &c.

Aluminium-Base Alloy.

Composition (approximate) :	
Aluminium	92 per cent.
Copper	8 per cent.
Casting Limitations :	
Maximum weight of casting	10 lb.
Minimum wall thickness :	
Small castings	$\frac{1}{16}$ in.
Large castings	$\frac{1}{8}$ in.
Variation in size of castings per linear inch	± 0·0025 in.
Threads :	
External (maximum number per inch)	20
Internal	Very rarely cast
Minimum Size of Holes : (Depends on length of hole and size of casting)	$\frac{1}{32}$ in.
Draw :	
Cores (per inch of length and diameter)	0·015 in.
Side walls (per inch)	0·005 in.
Physical Properties :	
Colour	Silver white.
Specific gravity	3·003
Weight per cubic inch	0·115 lb.
Melting point	1,150 deg. F.
Initial fusing point	1,025 deg. F.
Tensile strength	21,000 lb. per square inch.
Elongation	1·5 per cent.
Compressive strength	38,000 lb. per square inch.
Hardness (Brinell)	60·5
Chemical Properties :	
Reactions :	
Atmosphere	No reaction.
Alkalis	Soluble.
Nitric acid	Not soluble.
Hydrochloric acid (dilute)	Soluble.
Hydrochloric acid (concentrated)	Slightly soluble.
Sulphuric acid (dilute)	Soluble.
Sulphuric acid (concentrated)	Slightly soluble.
Organic acids	Little reaction.

This alloy will retain a lustre after polishing for a long period.

Application :

Aluminium alloys are used most widely, chiefly on vacuum cleaners, phonographs, cameras, and automobiles. As the products formed with organic acids are harmless, this alloy may be used in food containers.

In alloying or melting these metals they react with a certain amount of the cast iron of the containers. In the case of a copper-aluminium alloy similar to the one described above, the iron combines with the aluminium, forming $FeAl_3$. Certain non-metallic compounds also form, and small pieces of scale from the containers are washed into the alloy. Small particles of these compounds studded through the casting form what are known as "hard spots," because they are harder than the alloy itself. Ordinarily these compounds are not objectionable. In some cases, however, it is difficult to machine castings, as the hard spots dull the tools so quickly. At times the entire spot will tear out, leaving a small jagged hole in the casting.

The greater the amount of iron in the metal, the higher will be its melting point. Greater sluggishness accompanies these increases, so that the mould fills with more difficulty. The usefulness of the alloy becomes questionable when its iron content is in excess of 3 per cent.

In cases where the volume of the casting greatly exceeds that of the gate, there is very little trouble due to the presence of iron. However, in the case of small castings that require a long gate of good size, so that the volume of the gate greatly exceeds that of the casting, the increased presence of iron aggravates this condition. In this case a large percentage of the metal cast (the gate) returns to the pot for remelting. In this way the metal dissolves more cast iron on each return to the melting pot.

(To be continued.)

ILLINOIS CENTRAL RAILROAD ELECTRIFICATION.

THE electrification of the Illinois Central Railroad suburban system, about to be carried out in the Chicago district, will include tracks extending to Matteson on the main line and also the South Chicago and Blue Island branch lines. These tracks will have a route length of some 36 miles, while 100 miles of single line will be used. The new system is intended to afford transit facilities for approximately 30 per cent. of the suburban residents at present using steam trains to enter and leave the city of Chicago. This city has a population exceeding three millions, of which a large proportion travel to and from business, so that the magnitude of the transport problem is considerable. Contracts for electrical equipment to the value of 1,755,300*l.* have already been placed. This electrified service, similar to the constant-current 1,500-volt system now operated at Philadelphia by the Pennsylvania Railroad, will embrace the most modern type of rolling stock embodying aluminium and light metal alloys in its construction. The latest improvements in seating arrangement, heating, ventilation and illumination are to be adopted.

The number of cars ordered provide for a train service having four-minute intervals during the morning and evening rush hours. Trains will vary in length from two to ten cars according to traffic requirements and will be composed of units of two cars. One car of each pair will carry four motors, with the necessary control gear, while the second car will act as a trailer, accommodating the necessary apparatus for lighting, heating, signalling, and door operation. The motor equipment will include 260 Westinghouse 750/1,500-volt 250-h.p. motors. Each motor-car will have the motors arranged for series-parallel operation with field control, two motors being permanently connected in series. The gearing permits of speeds up to 65 m.p.h. being obtained. The coupling of the car units making up the train will be completely automatic, both in regard to the air and control cable connections. The normal horse-power of one of the trains will be 5,000, and the peak power developed will exceed 6,000 h.p.

CATALOGUES.

Motors and Dynamos.—The A.C.E.C. Company of Charleroi have sent us a copy of the latest issue of their list of motors, dynamos, switches, &c., now in stock ready for delivery.

Drill Sockets.—A priced list of drill socket adaptors for Morse taper shanks Nos. 1 to 5, is to hand from Messrs. William Asquith, Limited, Halifax. These adaptors are hardened and ground to a fine degree of accuracy.

Roller Bearings.—Messrs. Delco-Remy and Hyatt, Limited, 56, Victoria-street, London, S.W., have sent us further issues of their technical leaflets dealing with roller-bearing construction for light truck wheels, hand and power crane wheels and winches.

Fans.—A catalogue of pneumatic transport fans and settlers with belt, direct engine, or electric motor drives is to hand from the Blackman Export Company, Limited, 374, Euston-road, London. The settlers referred to are dust-collecting apparatus for warehouses and factories.

Woodworking Machine.—The Hutchinson Manufacturing Company, Inc., 18, South Seventh-street, Philadelphia, U.S.A., have sent a catalogue of their universal woodworking machine for ripping or cross-cutting up to 1½ in. thick, and fitted with planing, grooving, boring and other attachments.

Pipe Fittings.—A catalogue of connections, branches and other parts and accessories for pipe fitting, has come to hand from the British Steam Specialties, Limited, Fleet-street, Leicester. The fittings are made in wrought, cast, and cast-malleable irons, and in qualities suitable for low and high pressures.

Pickling Process.—The fourth edition of their useful little pamphlet containing a description of their pickling process for removing scale from wire, sheets, tubes, hollow-ware and castings is to hand from Messrs. Fergusson, Wild and Co., Limited, 13, St. Helen's-place, London, E.C. 3, who supply a pickling preparation.

Electric Vehicles.—A catalogue of trucks, of several sizes, some with trailers, and passenger cars using electric storage batteries, is to hand from Messrs. Drake and Gorham, Limited, 36, Grosvenor-gardens, London, S.W. These trucks are mainly for service in warehouses, yards, &c., or on good road surfaces. For many uses they are becoming increasingly popular.

Friction Linings.—Messrs. Ferodo, Limited, Chapel-en-le-Frith, Derbyshire, have sent us a special catalogue which they have issued of friction linings for the brakes, clutches, &c., for colliery winding and hauling engines, and other machinery. The catalogue contains many illustrations and a great deal of practical information which should be of value to colliery engineers.

Tramway Motor Gears.—The Metropolitan-Vickers Electrical Company, Limited, Trafford-park, Manchester, have issued a special catalogue of toothed pinions and wheels for tramway motors. These gears are made in several kinds of cast and forged steel and to fit some eight different makes of motor equipment. They are cut with straight spur or helical teeth as required.

Tools and Supplies.—A catalogue of tools, small machines and general supplies, including fitters' tools, tube brushes, jointings and packings, Morse lamps and tapper keys, &c., is to hand from Messrs. W. Crockatt and Sons, Limited, 64, Darnley-street, Glasgow. The small machines are for valve re-seating, cylinder boring, tube cleaning and expanding, &c.

Street Lanterns.—A lantern specially designed for street lighting with high-powered gas-filled lamps has been produced by the General Electric Company, Limited, Magnet House, Kingsway, London, W.C., who have sent us a copy of a special catalogue describing its construction. The difficulties of overheating and breakage by rain splashes have been specially guarded against. The lantern is called the "Wembley."

Sands.—The many uses of sand and the most suitable kind for different purposes have been made a special study by Mr. A. L. Curtis, Chatteris, who sends us a copy of his catalogue containing many notes on sands required in agriculture, various building and paving works, metal casting and cleaning, glass cutting, filtering, and other processes. The remarks on the size of grain and the presence of clay or other materials show that the selection and treatment of sand should be regarded as a matter for expert consideration.